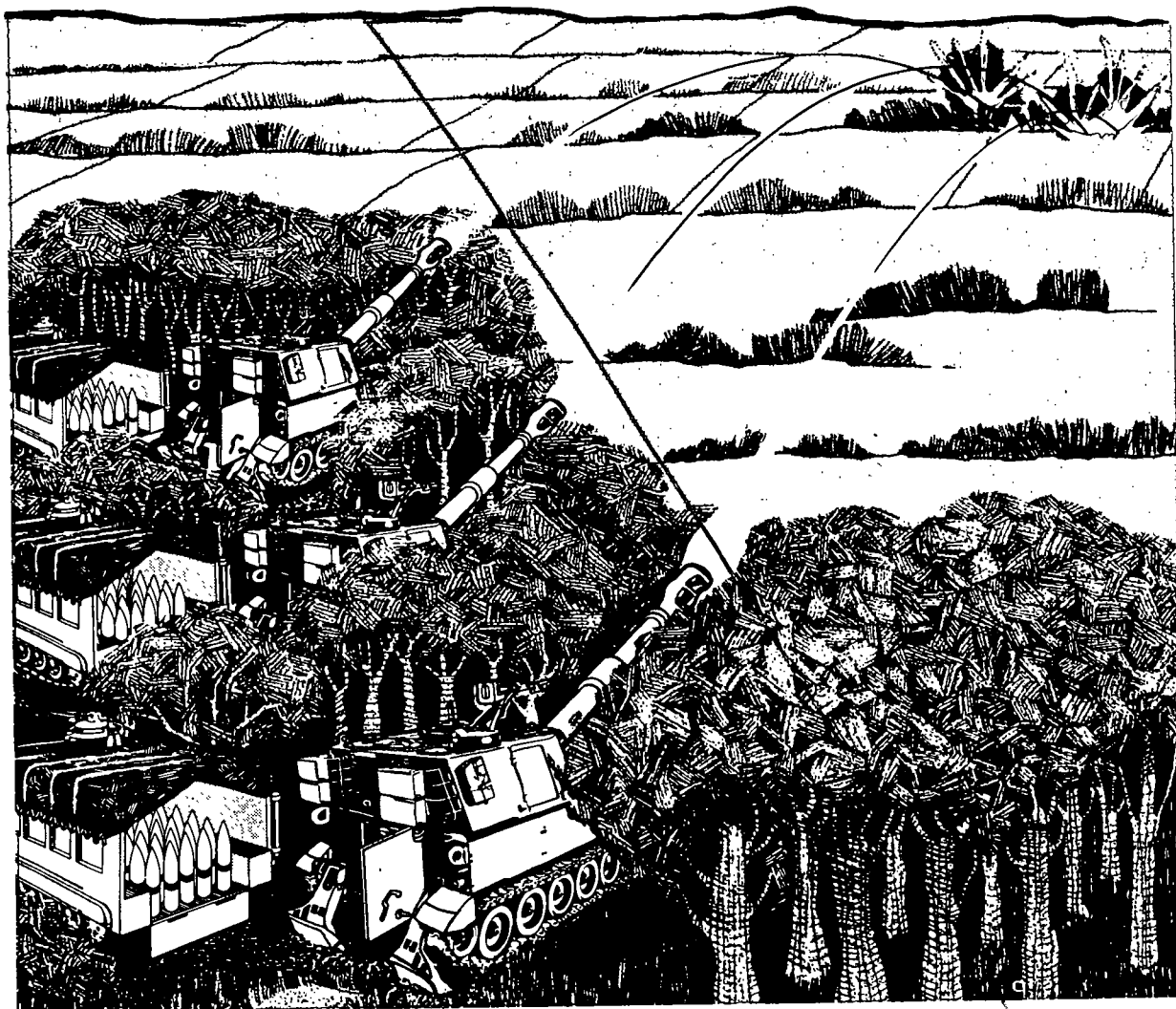


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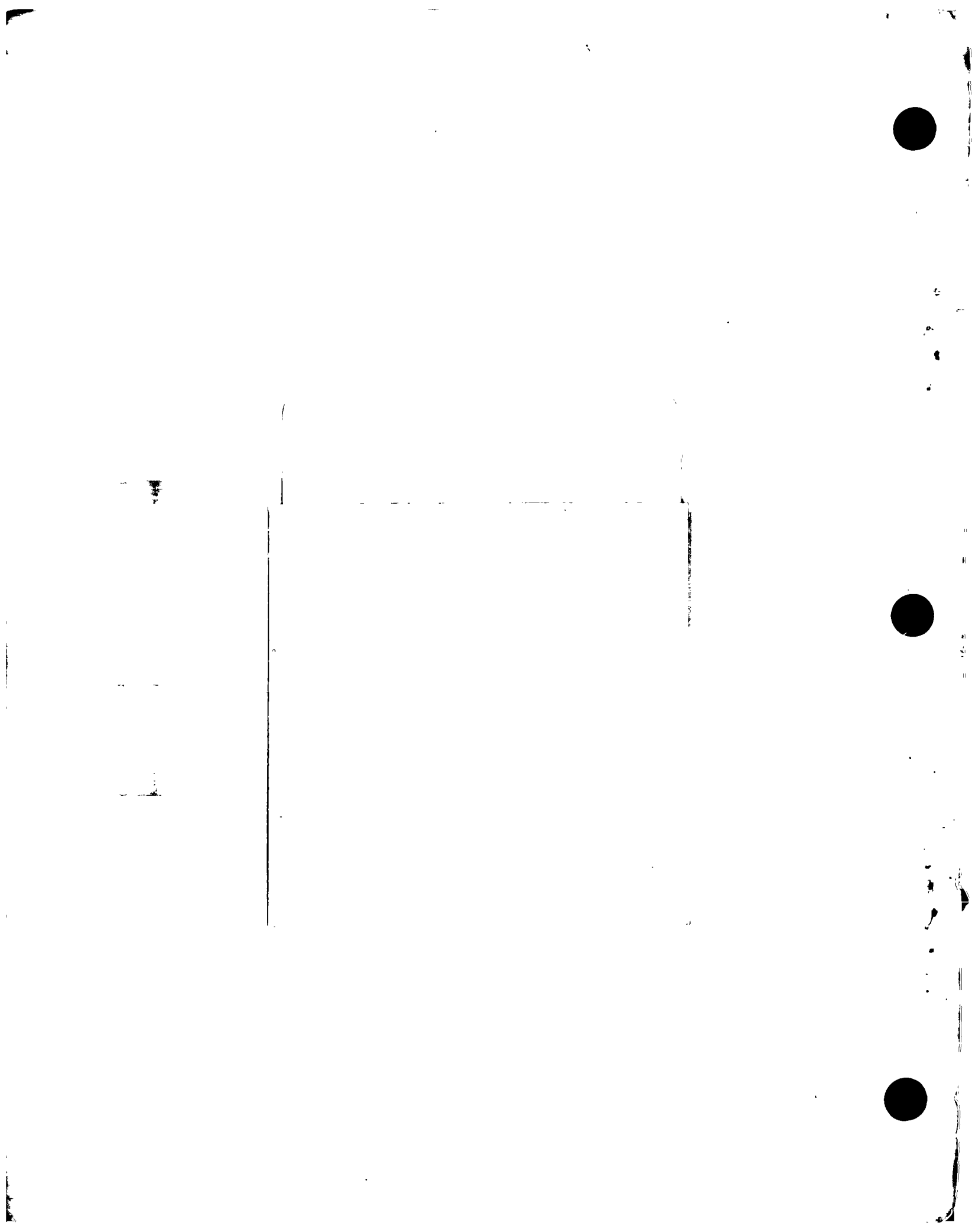
THE FIELD ARTILLERY CANNON BATTERY



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**FIELD MANUAL
NO. 6-50**

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THE FIELD ARTILLERY CANNON BATTERY

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PREFACE

This new manual is designed to serve as the reference document for the cannon battery for training as well as fighting. Its primary target audience is the cannon battery leader.

As you review this manual you will find discussed therein certain personnel and equipment not currently authorized by TOE. In addition, new techniques and changes in responsibility are described. Each of the major changes is discussed below. TOE changes have already been submitted for most of these items and completion of TOE actions is expected in the very near future.

Changes In Personnel

- *The fire direction officer (FDO).* The role of the FDO has been broadened with respect to safety responsibilities during service practice firing. He is now specifically charged with the task of computing the safety diagram and for disseminating safety information to the howitzer/gun chiefs of section.

- *First sergeant.* The mission of the first sergeant has been modified to indicate that he is the individual in the firing battery that is responsible for establishing the defense of the battery area. He works in conjunction with the XO in the development of his plan, which when finalized, is submitted to the battery commander for approval.

- *Gunnery sergeant (GSG).* An additional E7 has been added to the firing battery headquarters of each organization. His specific duties are discussed throughout this manual.

- *The added responsibility of developing survey control data (both direction and location) has been imposed on all firing battery leaders.* They must now be trained to perform simultaneous observation, observation of Polaris, and directional and graphic traverse.

Changes In Equipment

- All howitzer battery TOE will be modified to reflect a VRC-46 and VRC-47 mounted in the battery FDC vehicle; and a VRC-47 mounted in the BOC vehicle. This configuration permits retention of the battery commander's VRC-47 mounted in a 1/4-ton truck, provides the flexibility needed by the BC to conduct reconnaissance and still monitor his traditional nets while away from the battery, and does not seriously degrade the dedicated battery mission when the BC's vehicle is not present at the BOC.

- An additional M561 gama goat vehicle will be added to those TOE (towed) which require it, to be used as a BOC vehicle.

- Low-power radios will be added to the TOE as indicated in the manual. These will provide the backup intrabattery communications system. (Hot loops will no longer be needed.)

- To enhance wire communications, a loudspeaker LS-454 has been added to each SP howitzer section. A remote unit C-2328/GR will be added to each towed howitzer section to be used as indicated in chapter 13.

- An SB-993 will be added to those cannon batteries that do not have one. With the SB-22 switchboard utilized in the FDC to process multiple fire missions the BOC will now have the capability to terminate non-fire direction wire lines and provide satisfactory interim intrabattery communications pending the fielding of TACFIRE, the battery computer, and gun display units.

- The ammunition trailer M332, will be reinstated in cannon battery TOE. The exact distribution of these trailers has not been resolved at this time.

New Techniques

- In addition to the manual solution for determination of minimum quadrant elevation, this FM provides rapid fire tables which allow the XO to determine minimum QE more quickly and with considerably less chance for mathematical error.

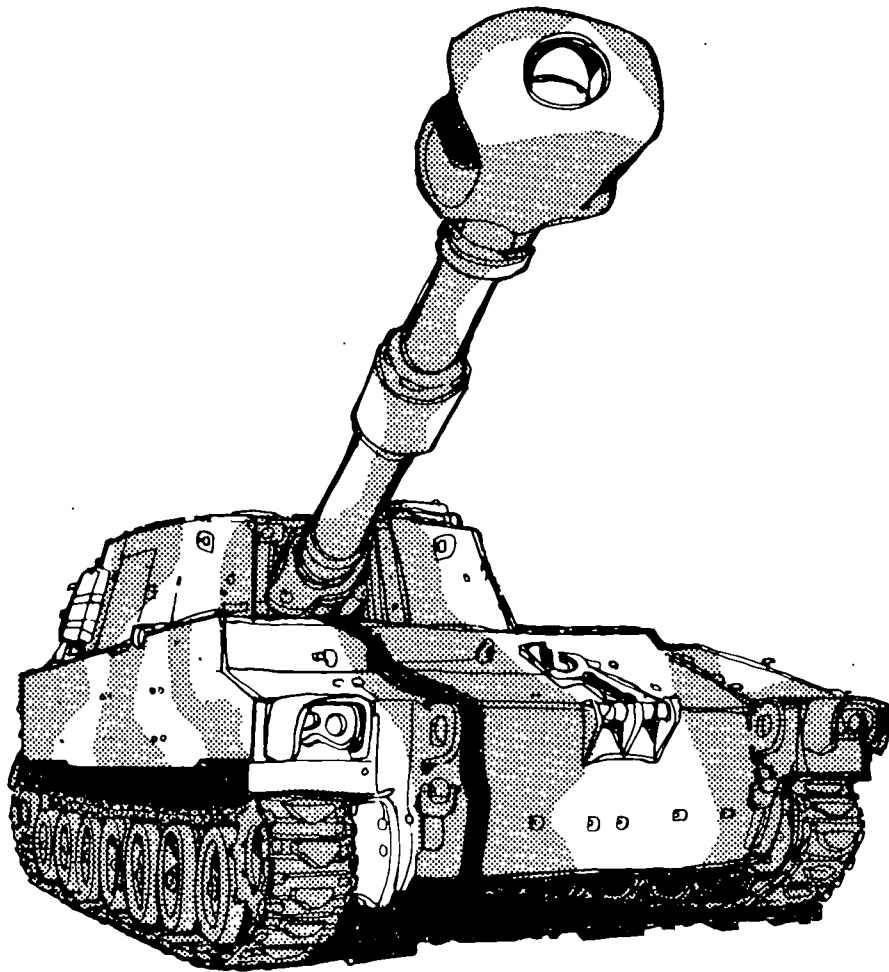
- The method of determining piece displacement has been changed to satisfy the FDC's need for determination of terrain gun position corrections (TGPC). The XO's report now includes the deflection and distance from the aiming circle to each piece, rather than piece displacement forward/behind and left/right of battery center as in the past.

- The fire commands contained in FM 6-40 have been modified and streamlined in order to increase responsiveness. Additionally, allowance has been made for standardization of many of the elements. These designated elements need be announced *only* when something other than standard is to be fired.

- Allowance has been made in the new fire commands for the nonadjusting pieces in a fire mission to load up the fire for effect ammunition *immediately* after receipt of the initial fire commands. This technique can be utilized whenever fuzes quick and VT are to be fired and is recommended for inclusion in unit SOP's.

PART ONE

GENERAL



- CHAPTER 1 -- INTRODUCTION
- CHAPTER 2 -- THE FIELD ARTILLERY CANNON BATTERY

CHAPTER 1

INTRODUCTION

1-1. Purpose

This manual has been prepared solely for the cannon battery. It is developed as a *how-to-train* and *how-to-fight* manual-intended to guide the commander and his principal subordinates through the planning and execution of a sound training program and to assist in the fielding of combat-effective tactical units. It sets forth the responsibilities and duties of key personnel as they pertain to training and fighting and recommends methods by which the commander can best manage his equipment and personnel assets. It is designed to be used by cannon battery leaders and should be used in conjunction with user's manuals for the appropriate weapon and other applicable technical and field manuals.

1-2. Scope

While FM 6-20 covers the entire spectrum of

fire support for combined arms operations, this manual deals specifically with the basic fire support unit, the field artillery cannon battery. It specifically addresses offensive and defensive tactical doctrine and procedures for the battery and provides guides for the training and testing of section personnel. A comprehensive list of references is at appendix I.

1-3. Changes and Corrections

Users are encouraged to submit recommended changes and/or comments to Commandant, US Army Field Artillery School, ATTN: ATSF-TD-TM, Fort Sill, Oklahoma 73503. Comments should be keyed to specific page, paragraph and line. Rationale should be provided in support of comments to insure complete understanding and evaluation.



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CHAPTER 2

THE FIELD ARTILLERY CANNON BATTERY

Section I. ORGANIZATION AND MISSIONS

2-1. General

The field artillery must provide continuous and timely support to a maneuver force by neutralizing and/or destroying, in priority, those surface targets most important to that force. The field artillery cannon battery is one of the firing units of the field artillery cannon battalion. It has the personnel and equipment necessary to deliver fire, to communicate, to move, and to perform limited administration. The cannon battery may operate as a separate tactical unit for limited periods of time. When the battery is operating independently, additional personnel and equipment may be attached to meet the requirements of the mission.

2-2. Organization

a. The organization of all cannon batteries is fundamentally the same (fig 2-1). Differences in organization stem from the caliber of the weapon, whether it is towed or self-propelled, and whether the battery is in a divisional or non-divisional battalion. The battery consists of the--

- (1) Battery headquarters.
- (2) Communications section.
- (3) Firing battery.

(*a*) Light and medium batteries (105-mm and 155-mm howitzer) have six cannon sections.

(*b*) Heavy batteries (8-inch howitzer and 175-mm gun) have four cannon sections.

- (4) Ammunition section.

(5) Forward observer (FO) section(s) in direct support (DS) units.

b. The battery headquarters provides the personnel and equipment required to perform the administrative, mess, supply, and maintenance functions for the battery. References covering these operations are in appendix I.

c. The communications section works in conjunction with the battalion communications section to install and maintain communications for the battery.

d. The firing battery consists of the personnel and equipment required for determining firing data and firing the cannons. It includes the firing battery headquarters, the battery fire direction center, and the howitzer sections.

e. The ammunition section consists of the personnel and equipment necessary for battery ammunition resupply.

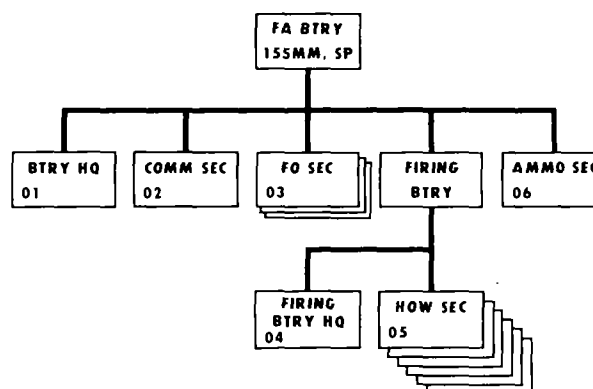


Figure 2-1. Divisional (DS) 155-mm self-propelled battery.

f. The field artillery battery of the armored cavalry squadron (howitzer battery) is a modification of the artillery battalion cannon battery. It is designed to function independently and to perform most of its own support functions. It is organized, trained, and equipped to provide direct support for the armored cavalry squadron. Figure 2-2 shows the organization of this battery. A significant addition to the howitzer battery is the battery detail, which includes the communications section, a FADAC repairman, and a survey section.

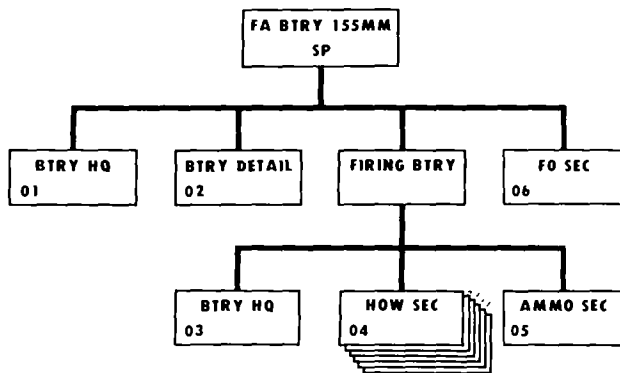


Figure 2-2. Field artillery battery, armored cavalry squadron.

2-3. Tactical Missions

a. When a cannon battalion is assigned a tactical mission of *DIRECT SUPPORT*, the cannon battery provides fire support to a specified maneuver force, usually a maneu-

ver battalion. Forward observer sections from the cannon battery are provided to the maneuver elements of the supported unit. When a cannon battalion is assigned a tactical mission of *REINFORCING*, *GENERAL SUPPORT-REINFORCING*, or *GENERAL SUPPORT*, the cannon battery reinforces the fires of another artillery unit or provides fires for the force as a whole as directed by the force artillery headquarters. Details on communications requirements and other responsibilities are outlined in FM 6-10 and FM 6-20.

b. Additionally, the battery may function in a *DEDICATED* role. Dedicating the fires of a battery is an extension of the direct support mission to be used when the maneuver brigade is moving to contact. In a dedicated role, a battery provides fire support to a specifically designated maneuver company/team. Fire planning considerations and techniques are discussed in FM 6-20 and 6-40-5.

Section II. DUTIES OF KEY PERSONNEL

2-4. Battery Commander

a. The battery commander (BC) is responsible for everything his command does or fails to do. Some specific responsibilities are listed below.

- (1) Insuring that the battery accomplishes its mission.
- (2) Training the battery for combat.
- (3) Maintaining materiel and equipment.
- (4) Maintaining high standards of discipline and morale.
- (5) Preserving the health and physical fitness of the battery personnel.
- (6) Insuring adherence to proper safety precautions.
- (7) Performing reconnaissance, selection and occupation of the battery position.
- (8) Maintaining ammunition supply.
- (9) Supervising the activities of the fire direction center (FDC) when necessary.

(10) Insuring the battery's survivability, to include preparing an adequate defense and proper concealment.

(11) Planning and controlling the unit marches and movements.

(12) Supervising the security, preparation and delivery of special weapons, if applicable.

(13) Insuring that the battery functions in accordance with regulations and policies of higher commanders.

(14) Keeping the battalion commander and the personnel in his battery informed of the current situation.

(15) Establishing and maintaining a high degree of communications and electronics security.

(16) Managing the assignment of personnel within the battery.

b. In carrying out his command responsibilities, the battery commander--

- (1) Plans his training program. He fol-

lows up on the progress of training by personally supervising and participating in the training.

(2) Makes frequent inspections to insure that his orders are being carried out; that living quarters are adequate and well policed; that food is appetizing, properly prepared, and served on time; and that routine work is equitably distributed.

(3) Makes himself available for discussions with battery personnel on matters of a personal nature.

(4) Maintains discipline.

(5) Manages the assignment of personnel to insure the right man is placed in the right job.

(6) Insures the responsiveness of the personnel support system to the needs of the individual.

(7) Instructs and cross-trains key subordinates in their duties.

(8) Keeps his troops informed.

(9) Emphasizes the maintenance and proper use of all equipment.

(10) Insures application of the principles of supply economy.

(11) Assigns responsibility and delegates authority to his officers and noncommissioned officers consistent with their positions.

c. The plans and orders of the battery commander are based on those received from the next higher command and his personal desires. These plans set forth a logical sequence for actions by each battery element in the accomplishment of the battery mission. The battery commander normally issues brief and informal oral orders. These orders fit specific situations and do not repeat standing operating procedures (SOP).

2-5. Executive Officer

a. The executive officer (XO) is the battery commander's principal assistant. During the BC's absence, the XO is the acting commander and assumes all the duties and responsibilities discussed in paragraph 2-4.

When the BC is present, the XO ordinarily commands the firing battery portion of the battery. In some tactical situations, the XO may also perform the duties of the fire direction officer (FDO).

b. The XO is specifically responsible for-

(1) Supervising the battery as it occupies the firing position, and insuring the track plan (para 4-5) is followed.

(2) Laying the battery upon occupation of a position.

(3) Measuring and reporting piece direction as required.

(4) Determining the minimum quadrant elevation.

(5) Insuring that boresighting is accomplished as soon as possible and as often as necessary.

(6) Insuring that timely and accurate fires are delivered by the howitzer sections.

(7) Insuring that before-, during-, and after-operation maintenance is conducted.

(8) Insuring that position area improvement (hardening, camouflage, etc.) begins as soon as possible and progresses at an acceptable rate.

(9) Insuring that ammunition is properly protected from the elements and enemy fire.

(10) Rendering the XO's report to the fire direction center (FDC). As soon as the information is available and without delaying the preparation of fire, the XO reports to the FDC that *the battery is laid and reports the referred deflection, the minimum quadrant elevation for each charge and the deflection and distance from the aiming circle to each piece.*

(a) Sometimes it is necessary to determine more than one minimum quadrant elevation for the sector of fire. In this case, the XO reports each minimum quadrant elevation and its related azimuths (e.g. AZIMUTH 4850 TO 5200, MINIMUM QUADRANT ELEVATION FUZES QUICK AND TIME, CHARGE 3 GREEN BAG, 100; AZIMUTH 5200 TO 5650, MINIMUM QUADRANT ELEVATION FUZES QUICK AND TIME,

CHARGE 3 GREEN BAG, 104).

(b) When directed, the XO reports the amount, type, lot numbers, and weight of projectiles; powder temperatures; lateral limits of azimuth or deflection; maximum elevation when high-angle fire is to be used; and visible aiming points with referred deflections.

(11) Insuring that intra-battery communications is established as prescribed.

(12) Insuring that safe practices are observed, to include proper fire commands, safe firing data (not firing below minimum QE) and proper ammunition handling and storage.

(13) Insuring that each section chief knows the location of his supplementary position and that the route to this position has been reconnoitered.

(14) Coordinating with the first sergeant to determine fire sectors for each howitzer to complement the overall battery defense plan.

(15) Supervising the development of howitzer range cards.

(16) Insuring that ammunition is distributed to the howitzer sections according to anticipated needs as determined by the FDC.

(17) Insuring in coordination with the FDC that a standby (hot) platoon has been designated and that the priority target (if applicable) is assigned to the hot platoon.

(18) Training and supervising the activities of the firing battery.

2-6. Assistant Executive Officer

a. The assistant executive officer (AXO) performs duties as prescribed by the XO. He is normally charged with the responsibility of supervising the FDC. He must also be thoroughly familiar with the duties and responsibilities of the XO (para 2-5), since he may perform all or part of these duties in some situations. During 24-hour operations, the AXO and XO will normally divide the responsibility of supervising the FDC. The functional job title of fire direction officer (FDO) is used to refer to the officer performing that duty.

b. The FDO is specifically responsible for--

(1) Insuring the accurate and timely production of firing data.

(2) Assigning duties to personnel in a manner that facilitates continuous operation in shifts if necessary.

(3) Insuring that before-, during-, and after-operation maintenance checks are performed on the section vehicle, radios, computer, and generators.

(4) Insuring that locations of friendly units, boundaries, and coordinated fire lines are prominently posted and kept current.

(5) Insuring the proper use and functioning of battery wire and radio nets.

(6) When necessary, deciding how to attack a target and with what munitions and issuing the fire order.

(7) Insuring that FDC records are complete and accurate.

(8) Insuring that data for prearranged fires is properly disseminated and understood by FDC and howitzer section personnel.

(9) Inspecting the map and, if necessary, computing the minimum QE to intermediate crests not visible from the battery area.

(10) Insuring that the camouflage and position-hardening effort in the FDC area begins as soon as possible and progresses at a satisfactory rate.

(11) Insuring that accurate and complete fire commands are sent to the guns.

(12) Insuring that the quadrant announced in each fire mission is not below the minimum quadrant elevation for visible or intermediate crests.

(13) Coordinating with the battalion S3 to determine the type of ammunition to be requisitioned and making recommendations for changes to the basic load as needed.

(14) Coordinating with the XO to insure that a hot platoon has been designated and that the priority target, if applicable, is

assigned to the hot platoon.

(15) Preparing the safety diagram and verifying the plotting of safety limits on the firing chart.

(16) Insuring that the fire commands sent to the guns are within the specified safety limits.

2-7. First Sergeant

a. The first sergeant is the BC's primary enlisted assistant. As the senior enlisted man in the battery, he is the commander's primary enlisted supervisor. In peacetime, the specific duties and responsibilities of the first sergeant are dictated by the local SOP and vary from unit to unit.

b. In combat, the first sergeant's primary responsibilities are--

- (1) Overseeing battery administration.
- (2) Supervising the activities of personnel assigned to the battery headquarters.
- (3) Establishing the battery operations center (BOC).
- (4) Developing the overall defensive plan.
- (5) Coordinating directly with all enlisted supervisors and keeping them informed.

2-8. Chief of Firing Battery

a. The chief of firing battery (CFB) is the XO's principal enlisted assistant. He is normally charged with the specific responsibility of direct supervision of the howitzer section chiefs during training and combat operations.

b. The chief of firing battery must be prepared to perform all the duties of the XO.

2-9. Gunnery Sergeant

a. The gunnery sergeant (GSG) assists the chief of firing battery in executing his duties and must be prepared to perform all the duties of the XO.

b. His primary responsibilities are--

- (1) Performing the duties of the CFB during split battery operations.

(2) Working in shifts with the CFB during 24-hour operations.

(3) Assisting the BC in the reconnaissance of battery positions by--

- (a) setting up the aiming circle.
- (b) reading initial deflections to the gun guides.
- (c) supervising the activities of the gun guides.
- (d) Performing other duties in the new position that the BC may assign.

2-10. Howitzer Section Chief

a. In general, the chief of section is responsible for insuring that his section is trained, that all of his equipment is properly maintained, that correct, safe data are set on his weapon, and that proper safety precautions are observed during all tactical operations.

b. The section chiefs primary responsibilities are:

- (1) Conducting section training, both individual and collective.
- (2) Insuring that the weapon is properly emplaced and prepared for action.
- (3) Establishing section priorities for preparing the weapon and the firing position. Unless it conflicts with specific instructions from the XO or CFB, the memory aid TLAS-BAPP should be used as a guide for the accomplishment of the following tasks.

The section should be organized so that as many of these tasks as possible are accomplished simultaneously.

- (a) T Trail, spade or firing platform emplacement.
- (b) L Lay the weapon.
- (c) A Aiming points.
- (d) S Site to crest.
- (e) B Boresight.
- (f) A Azimuth markers.
- (g) P Prefire checks.
- (h) P Position area improvement (camouflage, hardening, etc.)

- (4) Measuring and reporting site to crest.
- (5) Determining piece-to-crest range.
- (6) Supervising the entire section during firing.
- (7) Observing and checking the functioning of materiel during firing and immediately reporting errors, unusual incidents, or equipment malfunctions to the XO or FDC.
- (8) Segregating ammunition by type and lot.
- (9) Insuring that before-, during-, and after-operation maintenance is performed in accordance with the applicable user's manual or TM.
- (10) Insuring that equipment is habitually stowed according to the unit's loading plans and as prescribed in the appropriate user's manual or TM(s).
- (11) Preparing range cards for the howitzer and section crew-served weapon(s) for assigned sectors.
- (12) Supervising the appropriate logbook entries and making equivalent full charge (EFC) computations in accordance with the appropriate user's manual or TM.
- (13) Controlling the firing of his howitzer during direct fire operations.
- (14) Redistributing the duties of personnel to facilitate mission accomplishment

when the section is operating with a reduced crew.

(15) Organizing the section into shifts to facilitate 24-hour operations.

(16) Insuring that the records discussed in paragraph 2-11 are completed correctly and that the data are kept current.

(17) Implementing the assigned portion of the battery defense plan.

b. The chief of section must be prepared to assume the duties of CFB/GSG if necessary.

2-11. Firing Battery Records

a. All records involved in the computation of firing data are discussed in FM 6-40 and 6-40-5. Appropriate equipment logbook forms are discussed in the weapons user's manuals or TMs.

b. Within the firing battery, the DA Form 4513 (Record of Missions Fired) (fig 2-3) is used by each section for recording data that have been designated as standard, fire commands, and a running cumulative total, by type and lot, of ammunition on hand. DA Form 4513 is available through normal publications supply channels.

c. Additionally, each gunner should have certain information recorded on a reference card for ready reference. The gunner's reference card shown in figure 2-4 is a sample format only and contains the minimum information necessary.

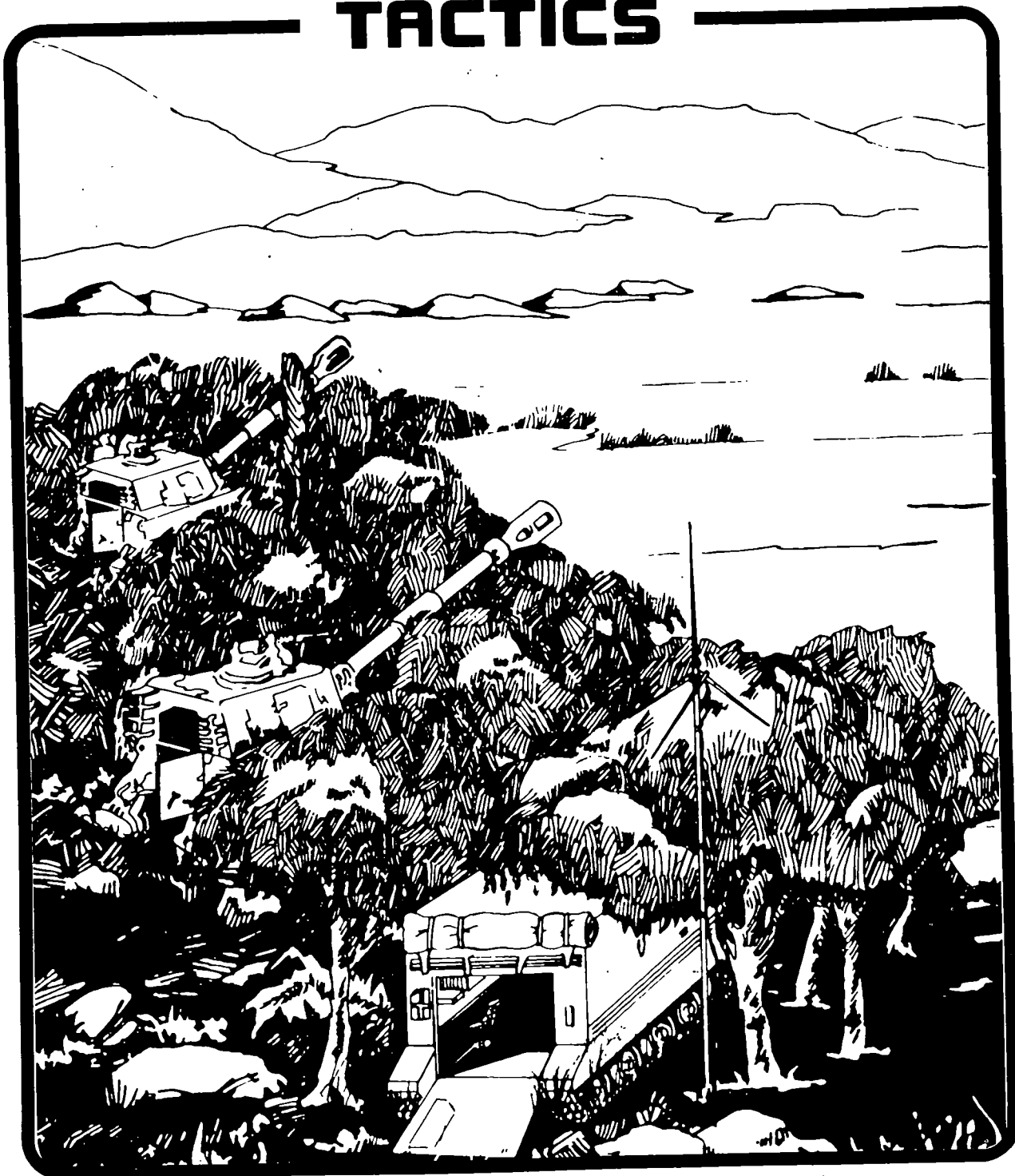
FM 6-50

GUNNER'S REFERENCE CARD										
AZ OF LAY										
DF TO AC					DIST TO AC					
DF TO COLL										
DF TO AP										
DF TO DAP										
MAX QE										
MIN QE										
STANDARDS		ADJ PIECE		SHELL		LOT		FZ		
PRIORITY TARGETS										
PRIORITY	TGT DESIG	SP INSTR	RDS	SH	LOT	CHG	FZ	TI	DF	QE
POSITION CORRECTIONS										
SECTOR		DF CORRECTION				QE CORRECTION				
PRIMARY										
LEFT										
RIGHT										

Figure 2-4. Gunner's reference card.

PART TWO

TACTICS



- CHAPTER 3 -- RECONNAISSANCE
- CHAPTER 4 -- SELECTION AND ORGANIZATION OF THE POSITION AREA
- CHAPTER 5 -- MARCHES AND MOVEMENTS
- CHAPTER 6 -- OCCUPATION OF POSITION: THE "O" of RSOP
- CHAPTER 7 -- DEFENSE OF THE BATTERY AREA

CHAPTER 3

RECONNAISSANCE

Section I. INTRODUCTION

3-1. General

On the modern battlefield, a sophisticated enemy is capable of locating and engaging a battery in a variety of effective ways. To survive we may be required to move frequently. Frequent movement, however, reduces responsiveness and necessitates greater reliance on other batteries assuming the mission during displacement. To minimize movement time, all key personnel must be capable of PERFORMING the reconnaissance, selection, organization, march, and occupation tasks QUICKLY and EFFICIENTLY. The keys to successful reconnaissance, selection, and occupation of position (RSOP) are discipline and team effort, which come from frequent and effective training.

3-2. Movement Considerations

a. The headquarters controlling the movement of the battery directs the essential elements of the movement--*when, where, and how*. These elements of movement may be specifically spelled out in an SOP or operation order or may simply be implied in the mission assigned.

b. Depending upon the tactical situation, the control headquarters may delegate to the battery the responsibility for any one or all of the essential elements of movement. The battery commander must anticipate movement. He must plan in advance for displacement to new, alternate or supplementary positions and announce movement techniques to be used. The battery commander should advise the controlling headquarters of any factors that they need to consider in determining the *WHO, WHEN, WHERE, and HOW* of the movement.

c. It is desirable that all key personnel of the battery understand the considerations involved in movement. *When* to move and *where* to move are covered in this chapter. *How* to move is covered in chapter 5. The unit

must be prepared to move--

(1) *To support the maneuver force.* A movement is indicated when the battery cannot cover a significant portion of the area of influence of the supported maneuver force.

(a) The one-third/two-thirds rule is appropriate in the offense. This rule means that it is time to move forward whenever only one-third of the range of the weapons extends beyond the forward edge of the battle area (FEBA). The displacement should be sufficiently forward so that at least two-thirds of the range extends beyond the FEBA. The reverse of the rule applies generally to the defense.

(b) It is desirable that all artillery be capable of covering the area forward of the FEBA that is visible to ground forces (3 to 5 km). Regardless of the responsibilities inherent in the mission assigned, the battery commander must know the tactical situation, anticipate when a displacement is needed, select positions in advance, reconnoiter when possible, and recommend to the battalion or maneuver force commander when and where the battery should displace.

(2) *During lulls in action.* If the battery needs to move because of a change in the FEBA, it may be best to move during a lull in combat action. A lull may not last long, so caution must be exercised.

(3) *When the position becomes untenable.* The battery should move whenever it cannot deliver effective fire because of enemy ground, air, or artillery attack. Depending upon the tactical situation, the battery may displace to one of its previously selected alternate positions. Again, anticipation is the key to minimum disruption. For further discussion of the tactical considerations in displacement and positioning, see FM 6-20.

Section II. RECONNAISSANCE: THE "R" OF RSOP

3-3. Definition

Reconnaissance is the examination of terrain to determine its suitability for accomplishment of the battery mission.

3-4. Receipt of Order

The battery commander may receive displacement orders ranging from a five-paragraph operation order to a simple authenticated radio message from higher headquarters. He is given, or selects himself, the general location of his new position, perhaps the azimuth of fire, the time to depart and/or be in the new position, and the routes to be utilized.

3-5. Methods of Reconnaissance

a. Before the BC can adequately plan for displacement, he should know the three methods of reconnaissance.

(1) *Map Reconnaissance.* All anticipated moves should begin with a map reconnaissance of the proposed position area and the routes to be traveled. Map reconnaissance is not totally reliable, as terrain features may have changed since the map was printed and true surface conditions cannot be determined. However, a map reconnaissance of tentative routes and proposed position areas should be made before a ground reconnaissance is conducted. Aerial photographs are usually more current and provide more detail of the area than maps.

(2) *Air Reconnaissance.* If the assets are available and the situation permits, an air reconnaissance should be made. The information gained from an air reconnaissance may be instrumental in the selection of specific route(s) to be used and areas to be occupied. Air reconnaissance is a fast method, but true surface conditions may not be distinguishable or may appear distorted. The pilot must be careful that his flight plan does not compromise the route or the new position area.

(3) *Ground Reconnaissance.* A ground reconnaissance is the best method of determining the suitability of routes to be traveled and positions to be occupied. The actual con-

dition of the route(s) to, and the terrain pattern within, the proposed area are seen as they exist. This method, however, is more time consuming than either the map or air reconnaissance.

b. Each method of reconnaissance offers the BC a different but complementary perspective of the best route to the best position. If the situation permits and time is available, all three methods may be used. In most instances, the BC performs a map reconnaissance, selects a tentative route, and then conducts a ground reconnaissance.

c. Vital information revealed en route which may adversely affect the unit displacing must be transmitted to the unit prior to its movement.

3-6. Planning the Reconnaissance

a. The governing factor in planning the reconnaissance is accomplishment of the mission. In a fast-moving tactical situation, the time available for *planning* the reconnaissance, *assembling* the party, and *conducting* the RSOP may be only minutes, excluding travel time.

b. The primary and alternate routes and distances to the new position area must be considered. A determination of how many route guides or markers will be needed should be made prior to departure.

c. The organization of the reconnaissance party should be tailored for the performance of specific duties. The BC takes to the new position ONLY the route guides and the personnel and equipment necessary for preparation of the position for occupation. These personnel also provide their own defense and initial defense of the new position area.

d. A standard nucleus of reconnaissance personnel should be established by SOP. The equipment required to prepare a new position should be preloaded (if possible) or identified and maintained in such a manner that it can be located and loaded on the prescribed vehicle without delay.

Section III. ORGANIZATION OF THE RECONNAISSANCE PARTY

3-7. General

The method by which the battery displaces and occupies a new position, day or night, is greatly influenced by whether or not a reconnaissance can be made and by the time available.

3-8. Reconnaissance Procedures

For either a deliberate or a hasty occupation, a prearranged signal or procedure should be used to alert and assemble the

reconnaissance party. The signal should be specified in the unit SOP, which should also list the personnel, equipment, vehicles and place of assembly.

3-9. The Reconnaissance Party

a. Two vehicles are usually required to carry the reconnaissance party and equipment. A suggested organization for a two vehicle party is shown in table 3-1.

Table 3-1. Reconnaissance Party, Self-Propelled and Towed Units

PERSONNEL	EQUIPMENT
Battery commander and driver	1 1/4-ton or 1/4-ton vehicle with radio, map, compass, and binoculars
First Sergeant	Map, grid sheet, overlay paper, coordinate scale, protractor (for construction of defense diagram), and NBC kit
One battery operations center (BOC) representative	Uses FDC equipment in BOC
Gunnery sergeant	BOC vehicle with fire direction equipment, RC-292 antenna, declinated aiming circle with tripod and night lighting device, one SB-16, one telephone TA-312, and one light machinegun
Gun guides (one per howitzer)	Pantel marking and guide stakes, compass, communication wire (to reach from weapon to SB-16, when available) and one set of aiming posts with night lighting devices (for night operations)
Communications chief (optional)	Mine detection kit
Required route guides	
Note: When preparing for night operations, all personnel should have flashlights with filters.	
Suggested number of personnel for a six-weapon battery (less required route guides) = 12.	
Suggested number of personnel for a four-weapon battery (less required route guides) = 10.	

b. If the situation is such that the BC can provide only one vehicle for his reconnaissance party, basically the same personnel and equipment listed in table 3-1 can be carried in the M561 Gama Goat. If the BC has to reduce the 12-man organization, he can eliminate the optional communications chief or specify one gun guide per two howitzers.

3-10. Taking a Firing Capability Forward

Depending on the mission and tactical situation, the BC may take an M548 ammunition carrier, a howitzer section, or a platoon forward with the reconnaissance party. Reasons for taking howitzers forward may be--

a. To register from the new position or perform an offset registration from a position outside the new battery position area.

b. To provide fire support to forces not supportable from the old position.

c. To confuse moving target locating radars, as part of the infiltration plan.

3-11. Occupation Without Reconnaissance

When the battery is moving, an emergency may arise that requires the battery to provide immediate fire support. While on the move the XO should continuously conduct a visual reconnaissance and inspect his map to confirm his present location. In anticipation of an emergency requirement, he should always be selecting the next suitable position area along the route of march.

3-12. Executing the Reconnaissance

a. Prior to departing for a new position area, the BC must give key information to his XO and reconnaissance party to provide continuity in the event he becomes a casualty. As a minimum, the BC should identify--

- (1) The mission.
- (2) The method of motor march.
- (3) The route of march.
- (4) The tentative location of battery center.

- (5) The azimuth of fire.
- (6) The time of displacement.
- (7) The general enemy situation.
- (8) The location of the release point.
- (9) The location of adjacent units.

The BC should also determine the tentative order of march of the cannons before departure. He may also designate an alternate route in the event the primary route cannot be used.

b. After making a map reconnaissance, completing his planning, and briefing necessary personnel, the BC is ready to proceed to the new location. While moving, he verifies the suitability of the primary route. He also checks--

- (1) Cover and concealment.
- (2) Location of obstacles.
- (3) Likely ambush sites (pre-plan suppressive fires as required).
- (4) Time required.
- (5) Distance.

c. If time allows the BC or a member of the reconnaissance party to return to the old position, he should check the alternate route.

d. Upon arrival at the new position area, the reconnaissance party should rapidly dismount and form a perimeter around the BC. The BC then directs the 1SG to have the personnel sweep the area that he desires to look at more closely. Under the supervision of the 1SG a sweep is made to insure that the area is free of enemy troops, boobytraps, mines and nuclear, biological, and chemical (NBC) hazards. *Care must be exercised at all times to keep the reconnaissance party and its vehicles concealed.* As the reconnaissance party sweeps through the area, a skeletal perimeter is established. This permits the BC freedom of movement after the sweep is completed. The sweep must cover the proposed position and also the surrounding terrain from which the enemy could attack. Observation posts should be established after the

initial sweep and maintained until the position is abandoned. During the sweep, the BC materializes the azimuth of fire on the

ground, tentatively organizes the position, and formulates his plan of occupation.

Section IV. TRAINING

3-13. General

Members of the reconnaissance party must be trained, both individually and collectively. Table 3-2 lists some of the major tasks to be accomplished by reconnaissance party personnel.

3-14. Training Program

a. A sound training program for a reconnaissance party can be conducted in three phases--

(1) *Phase I.* During phase I, all personnel who might logically be expected to be members of the reconnaissance party are trained in the individual skills indicated in table 3-2. This training can be integrated with normal section training and should be highlighted whenever possible during other training. The standards in appendix B of this manual should be used as a guide for training.

(2) *Phase II.* In phase II the battery commander conducts a tactical exercise without troops (TEWT) with key personnel of the reconnaissance party. Examples of how to

use this technique are discussed in chapter 17. This phase need not follow phase I, but in fact, the two phases might well be conducted simultaneously.

(3) *Phase III.* Phase III is a full rehearsal of the reconnaissance party in a simulated or an actual tactical environment. All the collective skills indicated in table 3-2 can be measured, critiqued, and reinforced during a full dress rehearsal. The commander must make rehearsals as realistic as possible. Reconnaissance party members should be rotated frequently in order to cross-train as many people as possible. The standards in the appropriate ARTEP should be used as a guide for the conduct of this training.

b. Remember that during combat, a unit maintains proficiency in those skills that are used day to day. If not used or practiced, skills that may be required later can be lost. Consideration should be given to conducting training during combat lulls. Such training will insure that a battery maintains its ability to perform all skills required.

Table 3-2. Major Reconnaissance Tasks.

MAJOR RECON TASKS	BC	XO	AXO	1SG	CFB	GSG	HOW SEC CHIEF	COMM CHIEF	BOC/FDC	BC's DRIVER	HOW SEC PERSONNEL
1. Select a tactically sound battery position. (C)	X	X	X	X	X	X					
2. Select alternate and supplementary positions. (C)	X	X	X	X	X	X	X				
3. Select proper locations for cannons. (I, C)	X	X	X	X	X	X	X				X
4. Conduct a security sweep of new position area. (I, C)	X	X	X	X	X	X	X	X	X	X	X
5. Select locations for administrative vehicles (mess, maint, ammo). (C)	X	X	X	X	X	X					
6. Select a proper site for the BOC and FDC. (I, C)	X	X	X	X	X	X		X	X		
7. Set up and hook up wire to the SB-16 when available. (I, C)				X	X	X	X	X	X		X
8. Set up, level and orient the aiming circle on the azimuth of fire. (I, C)	X	X	X	X	X	X	X				
9. Aline howitzer guide stakes on an azimuth with the compass. (I, C)					X	X	X				X
10. Orient the aiming circle over the pantel marking stake and direct the emplacement of aiming posts. (I, C)	X		X		X	X	X				
11. Select a route and guide a vehicle into position, adhering to the units track plan. (C)				X	X	X	X	X	X	X	X
12. Prepare a firing chart for use. (I)			X						X	X	
13. Compute firing data using a GFT fan. (I)			X						X	X	

Note: I = Individual training C = Collective training

Table 3-2. Major Reconnaissance Tasks--(continued).

MAJOR RECON TASK	BC	XO	AXO	1SG	CFB	GSG	HOW SEC CHIEF	COMM CHIEF	BOC/FDC	BC's DRIVER	HOW SEC PERSONNEL
14. Assemble and erect the RC-292 antenna correctly for a designated frequency. (I)								X	X	X	
15. Monitor NBC equipment and mine detector. (I)				X		X		X		X	
16. Lay the battery during an emergency occupation to answer an emergency call for fire. (I, C)		X	X		X	X	X				
17. Develop a sound track plan. (C)	X	X	X	X	X	X					
18. Determine distances needed for terrain position correction. (I, C)						X	X				X
19. Conduct a map recon. Select primary and alternate routes and checkpoints and determine the order of march for the cannons. (I,C)	X	X	X	X	X	X					
20. Using the M17 plotting board determine piece displacement for terrain gun position corrections. (I)	X	X	X						X	X	

Note: I = Individual training C = Collective training



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CHAPTER 4

SELECTION AND ORGANIZATION OF THE POSITION AREA

Section I. SELECTION CONSIDERATIONS

4-1. General

Having completed the route reconnaissance and arrived in the general area of the new battery position, the BC and his reconnaissance party conduct a sweep for enemy forces and prepare the position for occupation. Each member of the party must accomplish his job quickly and efficiently in order to insure maximum preparation for the arrival of the main body. The speed and smoothness of the actual battery occupation depend largely on the work of the reconnaissance party.

4-2. Selection Considerations

The following are position selection considerations:

a. Mission. This is the most important consideration. The position should provide for fire throughout as much of the zone of influence of the supported maneuver force as possible.

b. Tactical situation. The tactical situation will largely dictate the location of the position area, the technique of positioning the howitzers and the use of terrain in defense of the battery.

c. Communication. The position must facilitate communication, particularly with the forward observer(s).

d. Defilade. Defilade is protection from enemy observation and direct fire weapons by use of a terrain mask. The battery should not be positioned so close to the mask that the unit low-angle fire capabilities are restricted.

e. Defensibility. The position should facilitate both active and passive defense so that it--

(1) Can be entered without enemy observation.

(2) Offers effective cover and concealment with emphasis on concealment.

(3) Avoids high-speed approaches into the position from the FEBA.

(4) Has more than one entrance and exit route, preferably in the rear of the position.

f. Trafficability. The soil must be firm enough to support the vehicles of the battery, especially the loaded ammunition vehicles.

g. Weather. Weather conditions and the effect of weather on the terrain should be known.

h. Formations.

(1) Because of the ability of the enemy to detect your unit and react quickly, you must place more emphasis on concealment and survival than on positioning for best sheaf effects in the target area. A compact position is vulnerable to air attack and to counterfire. A straight-line cannon formation presents an easy target for strafing or low-level bombing attacks. Both of these formations should be avoided.

(2) Conforming to terrain patterns helps to conceal the position and provides better possibilities for firing to the flanks and rear. Terrain gun positioning should be the primary method of occupying a position area whenever possible. Terrain gun positioning is the utilization of terrain to provide the maximum concealment and protection from the enemy. It means fitting the howitzers to the rolls, folds, and vegetation of the occupied land mass. When the need for a 6400-mil firing capability is overriding and dictates the use of a small, tight, easily defended area, formations such as the star formation (fig 4-1) can be used.

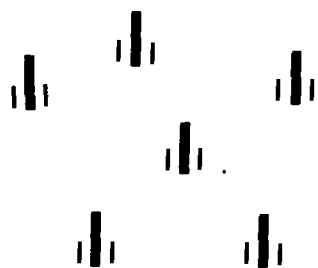


Figure 4-1. Star formation.

(3) Regardless of the type of formation, the howitzers are numbered from right to left and front to rear as they face the azimuth of fire (fig 4-2).

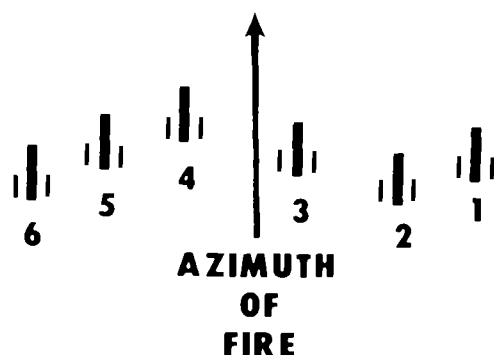


Figure 4-2. Howitzer numbering.

(4) The howitzers are also divided into platoons. Each platoon has two howitzers, and the platoons are referred to as *RIGHT*, *CENTER*, and *LEFT* (fig 4-3).

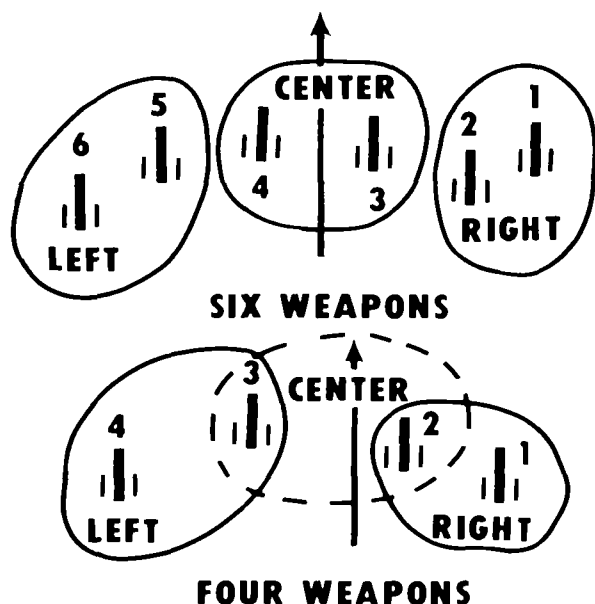


Figure 4-3. Platoon designations.

(5) Enemy attack capabilities may be so great and concealment so poor that either the battery must be spread over an abnormally large area or the howitzers must be grouped in small but scattered areas. Care must be exercised to insure that the area is not so large that the FDC cannot compute terrain gun position corrections (TGPC). Generally, if the cannons are within a 200-by-400-meter rectangle, the FDC can compute valid TGPC. For planning purposes, on favorable terrain a cannon battery will require an area as indicated in the following chart.

TYPE UNIT	DIMENSIONS
105mm	200 x 200 METERS
155mm AND 8-INCH	200 x 300 METERS
175mm	200 x 350 METERS

4-3. Positions

The BC has to consider three types of positions.

a. Primary position. The primary position is the position from which a battery intends to accomplish its assigned mission. It should meet most of the position selection considerations.

b. Alternate position. The alternate position is one to which the entire battery moves in the event its primary position becomes untenable or the battery has to move for other reasons. Since the battery will continue its mission from the alternate position, it must meet the same requirements as the primary position and should be just far enough away that the battery can escape the effects of enemy indirect fire on the primary position. *It should be reconnoitered and prepared for occupation as time permits.* Each section chief must know the route to the alternate position because movement to that position may be by section.

c. Supplementary position. A supplementary position is selected for accomplishment of a specific mission, such as for conduct of an offset registration, adjustment with a roving gun, or defense of the primary position.

(1) Supplementary positions for *defense* of the battery should be platoon sized, and selected to cover likely enemy avenues of approach. Routes to these positions must be reconnoitered by all gun guides and section chiefs.

(2) Positions for *offset registrations* and *roving guns* should be far enough from the primary position so that counterfire will not affect the primary position. The BOC will likely accompany the offset registering piece or roving gun. For more details, see FM 6-40 and 6-40-5.

4-4. Battery Installations

a. After the BC has selected the primary position, the reconnaissance party conducts a sweep and the BC tentatively selects positions for the howitzers and other battery installations. The primary consideration in selecting the location for the cannons is the capability of providing effective fire in support of the maneuver force. Other installations to be selected in organizing the firing position are--

(1) The line of metal. An ideal position is one that provides defilade without unduly restricting the minimum elevation that can be fired. Direct fire capabilities from the position should also be considered. Ideally, the howitzers will be arranged to provide the best effects in the target area while taking advantage of natural cover and concealment.

(2) Ammunition section. The ammunition section area should be concealed and protected. It should allow easy access to supply routes. Ammunition is normally left on the vehicles to allow rapid displacement of the unit. If it must be off-loaded it should be placed in an area that has good drainage. (Details on storage, care, and handling of ammunition are in chapter 14.)

(3) Battery fire direction center. The battery FDC should be located to minimize

the effects of counterfire. The FDC must be able to communicate with the FO's and battalion FDC. FM communications require electronic line of sight, so dead spots should be avoided if possible in selecting a firing position. A good map reconnaissance will normally reveal the positions where these dead spots are likely to occur because of line of sight.

(4) The battery operations center. The battery operations center (BOC) serves as both the battery command post and the alternate fire direction center. It should be located as far as is tactically feasible from the primary FDC to reduce the possibility that hostile fire will damage both. The radios in the BOC may be remoted outside the immediate vicinity of the BOC in order to reach marginal locations. The RC-292 antenna should be erected, when required, to enable communications with distant stations.

(5) Field exclusion area. For units with a nuclear capability, the field exclusion area (FEA) should be located in the most defensible part of the battery position area consistent with the availability of natural concealment and access routes. Requirements for establishing the FEA are in FM 100-(), Nuclear Unit Operations In Combat.

(6) Service area. When the battery support vehicles accompany the firing battery, a service area will be established. The service area contains the vehicle dispersal, maintenance, and battery mess areas. Since these installations are not directly related to the delivery of fire, they are located as far from the cannons as possible. The service area should be to the flank or rear of the cannons in an area that is accessible, that has firm ground, good drainage, cover, and concealment, and that provides adequate room for the dispersion of the vehicles. If terrain permits, vehicles should be separated by a minimum distance of 50 meters. All vehicles not required at the various battery installations should be parked in the vehicle dispersal area.

b. Figure 4-4 shows a typical battery position area.

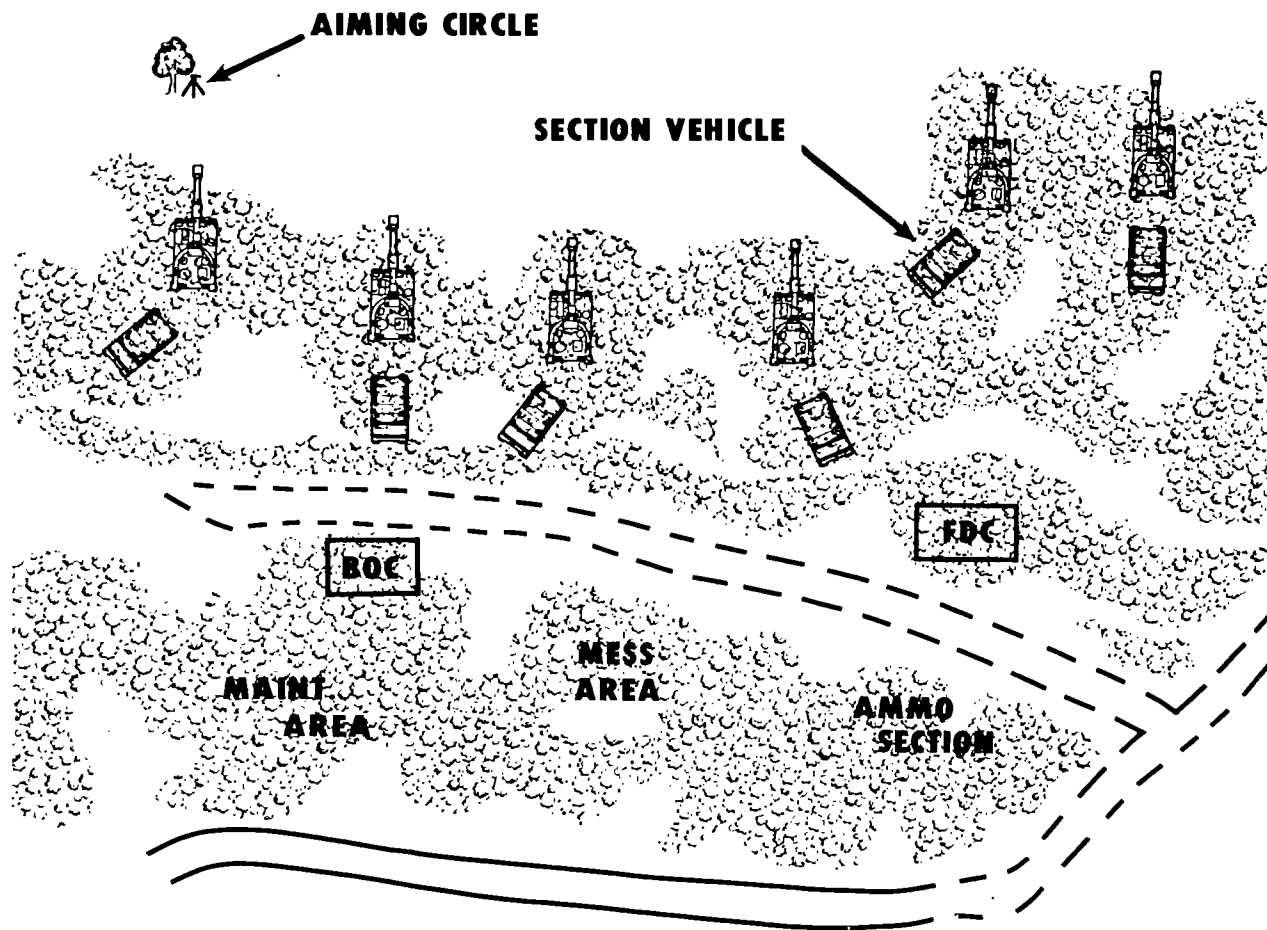


Figure 4-4. Type cannon battery position area.

Section II. PREPARATION FOR OCCUPATION

4-5. Preparation for Daylight Occupation

a. The BC finalizes his plan of occupation, giving priority to performing those tasks that facilitate immediate fire support to the supported maneuver forces. The plan is not limited to, but should include, the following:

(1) The location of the cannons and the battery center.

(2) The azimuth of fire, which the BC indicates by pointing out a terrain feature located on the azimuth or by pointing his vehicle in the direction of fire if a terrain feature is not available.

(3) Entrance and exit points. The BC

indicates these points and provides guidance to the 1SG for development of the battery track plan.

(4) The location of the battery installations such as the aiming circle, FDC, BOC, maintenance area, ammunition section, and mess area.

(5) Guidance on the scheme of defense.

(6) Location of the pickup point where the ground guides assemble to meet the battery. (Caution the guides not to bunch up!)

b. As soon as the plan of occupation has been given, the key personnel begin performing their duties. Specific responsibilities are:

(1) The BC establishes the specific position of each howitzer.

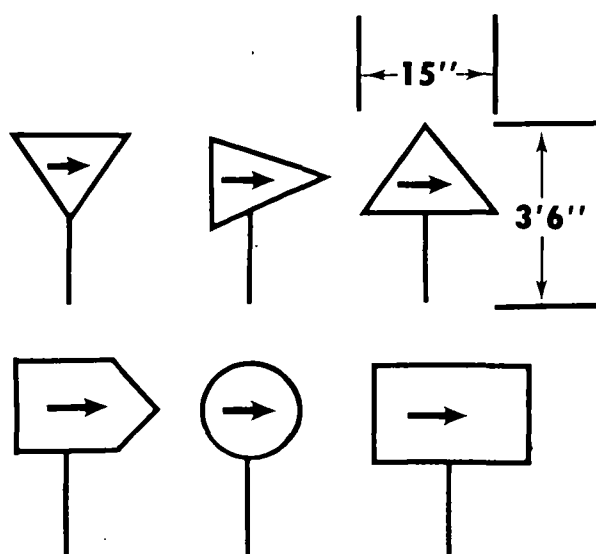
(2) The gunnery sergeant sets up and orients the aiming circle--

(a) Away from magnetic attractions when laying by grid azimuth.

(b) Where it will have line of sight with the panoramic telescopes.

(c) Where it can be concealed.

As soon as the panoramic telescope (pantel) marking stakes (fig 4-5) are emplaced, the GSG announces the deflection to each pantel marking stake. The gun guides record this information and give it to the gunner and section chief when the battery arrives.



Note. The arrow on each stake indicates the azimuth of fire.

Figure 4-5. Pantel marking stakes.

This deflection, along with the distance from each gun to the aiming circle, will be given to the BOC member for application to the M17 plotting board. If the BOC representative is unable to plot the piece displacement on the M17 plotting board before arrival of the FDC, the GSG gives the deflection and the distance from the aiming circle to each weapon to the FDO. The FDO uses these data in determining terrain gun position corrections (TGPC).

(3) Each gun guide--

(a) Emplaces the pantel marking

stake in the location designated by the BC. The pantel marking stake marks the location of the panoramic telescope of the weapon.

(b) Aligns the front and rear guide stakes on the azimuth of fire so that when he guides the weapon into position the weapon will be on the azimuth of fire. In self-propelled (SP) units, the guide stops the weapon with the front sprocket parallel to the front guide stake. This causes the panoramic telescope of the weapon to be over the hole left by the pantel marking stake. The proper emplacement of the pantel marking stake and guide stakes for SP units is shown in figure 4-6 and, for towed units, in figure 4-7.

(c) Receives and records the deflection to his pantel marking stake as read by the GSG.

(d) Paces the distance from his howitzer position to the aiming circle and reports the paced distance to the GSG. He double-checks the paced distance by pacing back from the aiming circle to the pantel marking stake.

(4) The BOC representative sets up the SB-16 and a firing chart as soon as the BC gives him the coordinates of the battery center and the azimuth of fire.

(5) The 1SG establishes the track plan, organizes the vehicle dispersal area, selects a position for each element in the service area and plans the perimeter defense of the position. In forming the track plan he considers the following:

(a) Existing roads and trails.

(b) The entry point to the position should be in the rear and at a location where foliage, trees, or other growth meets the main road or trail.

(c) Separate exit and entrance routes should be provided.

(d) Routes should follow natural terrain features such as gullies and tree lines and take advantage of natural overhead cover and concealment.

Vehicle guides are briefed on the track plan. If concealment is critical, the 1SG may dic-

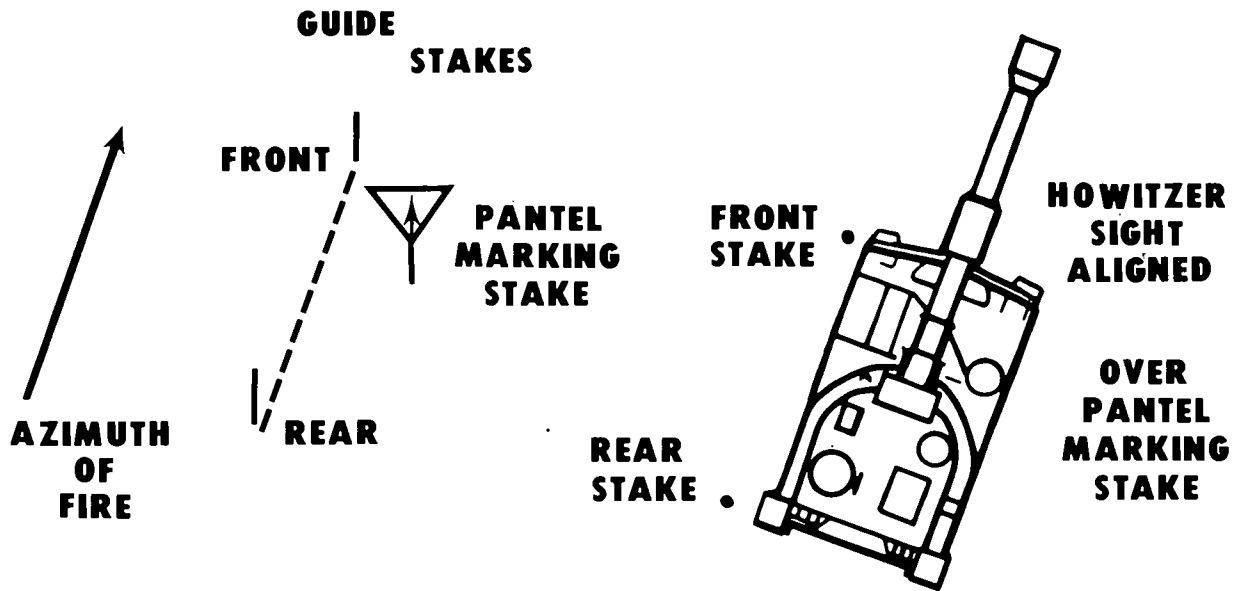


Figure 4-6. Use of stakes for SP weapons.

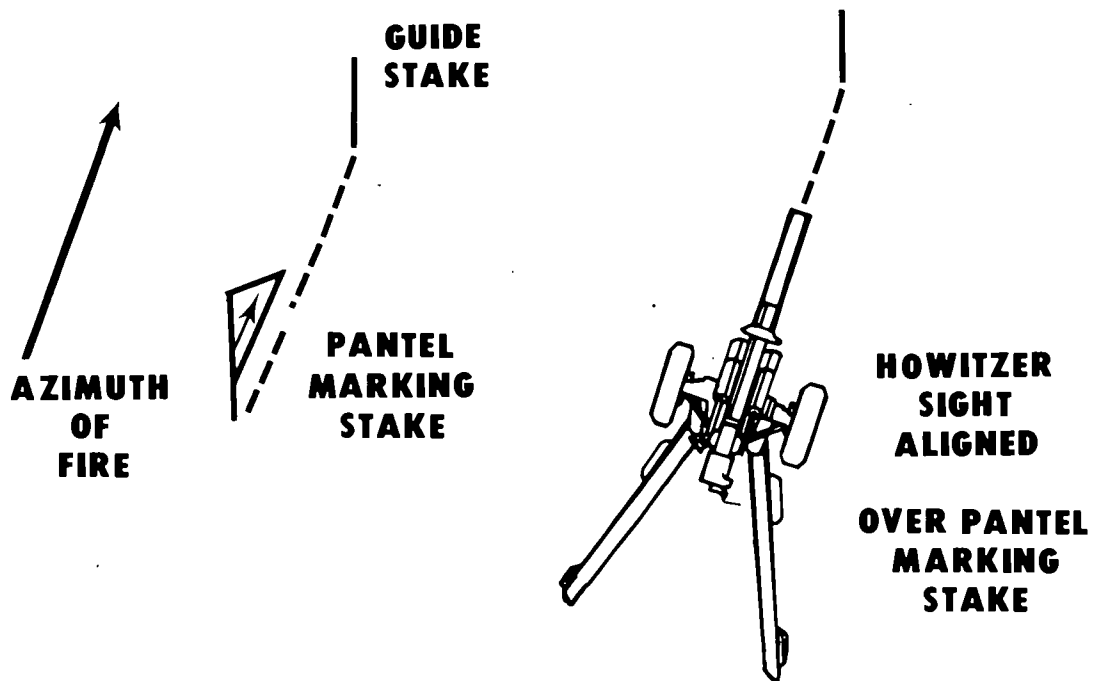


Figure 4-7. Use of stakes for towed weapons.

tate the exact route each vehicle is to follow. In SP units, situations in which sharp pivoting will disrupt ground cover must be avoided.

4-6. Limited Time Preparations

The following techniques are used in preparing the position when time is limited.

a. Duties are decentralized to the maximum extent possible. As soon as the BC selects the battery center, the gun guides select precise positions for their howitzers and are approved by the BC. (The gun guides must be trained to select proper gun positions without close supervision.)

b. One member of the reconnaissance party is left at the designated release point to guide the entire battery into position. Individual gun guides meet their respective vehicles as they approach their positions.

c. Service vehicles should be guided into position by the ISG and the BC's driver. If necessary, vehicles may be repositioned as soon as time permits.

d. The BOC representative and the GSG conduct their normal duties to the extent that time permits.

4-7. Preparation For Night Occupation

In addition to what has already been discussed, there are other tasks which should be performed as time permits to facilitate a smooth and orderly night occupation.

a. The GSG and gun guides should emplace the aiming posts prior to darkness, after the gun guides have recorded the deflections from the aiming circle to their pantel marking stakes. Unit SOP must designate referred deflections for the cannons to allow emplacement of aiming posts. The procedure for emplacing the aiming posts (fig 4-8) is as follows:

(1) After the GSG has read deflections to all pantel marking stakes, he marks the position of the aiming circle with a stake, a pole, or a section of an aiming post. (He does not use an aiming post section that has to be emplaced for any of the howitzers.) The GSG then proceeds to each howitzer position.

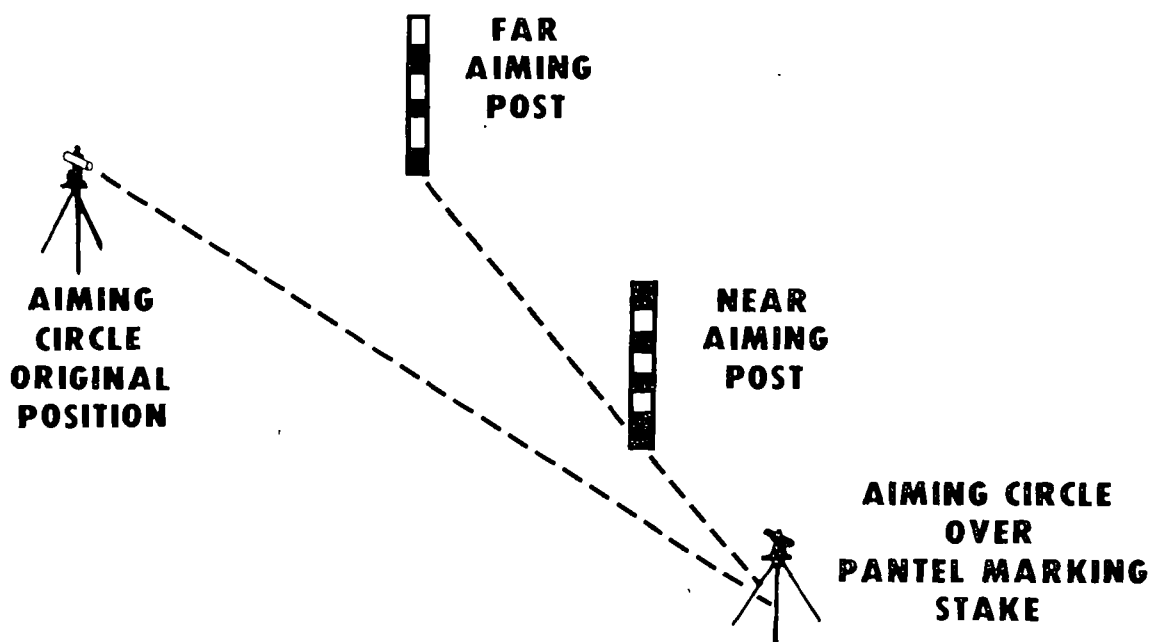


Figure 4-8. Emplacing aiming posts.

(2) He sets up, levels, and plumbs the aiming circle over the hole from the pantel marking stake over which the weapon sight will be positioned.

(3) With the *UPPER* motion, he sets off the deflection that he read earlier to the gun guide.

(4) With the *LOWER* motion, he sights on the stake (pole or aiming post section) emplaced at the original aiming circle position.

(5) With the *UPPER* motion, he sets off the deflection established by unit SOP for emplacing aiming posts.

(6) Sighting through the scope of the aiming circle, he then directs the gun guide to emplace the aiming posts. The night lights must be mounted and in operating condition prior to emplacement. Unit SOP should specify the alternating of red and green lights between sections.

(7) While the aiming circle is still oriented over the pantel marking stake hole, he measures the site to crest. The GSG repeats steps (2) through (7) at the remaining howitzer positions.

b. For a night occupation *every* vehicle should be guided into the position. These guides must be thoroughly briefed and should pace their routes before and after darkness. They should be equipped with filtered flashlights or have reflective tape on the back of their helmets to guide the vehicles. In many instances, assistant drivers may be used as guides for night occupation.

No vehicle should be allowed to move within the position at night without a guide.

c. Tentage used in the battery should be erected prior to darkness. A check for light leaks must be made. If daylight shows inside the tent, then artificial lights will show outside the tent at night.

d. Light sets and their generators may be brought forward, installed, and checked prior to darkness.

4-8. Preparing For Movement

Preparation for the move may include--

a. Periodically starting vehicles to insure they are capable of operating.

b. Taking up aiming posts.

c. Uncovering wire or removing it from trees.

d. Replacing section equipment in proper storage areas.

e. Reloading off-loaded ammunition.

f. Removing overhead cover.

g. Completely loading all service elements; i.e., mess, maintenance, etc.

CAUTION: THESE ACTIONS SHOULD NOT BE TAKEN UNTIL THE LAST MOMENT POSSIBLE. THE XO MUST KNOW HOW LONG IT TAKES HIS UNIT TO RECOVER AND BE READY TO MOVE.

CHAPTER 5

MARCHES AND MOVEMENTS

5-1. General

One of the essential ingredients in the delivery of timely and accurate fire is being in the right position at the right time. Getting to that position can be a difficult task. The movement of the battery must be accomplished quickly, with stealth and security. Making such a move requires considerable team training and discipline. The object of this chapter is to present information to assist in tactical vehicular marches of field artillery batteries.

5-2. Tactical Marches

A tactical march is the movement of a unit or elements of a unit under actual or simulated combat conditions.

There are several methods of moving the battery in a tactical configuration. Each method has its specific advantages and disadvantages. It is up to the commander to decide which method or combination of methods is best in any particular situation.

5-3. Open Column Road Movement

The open column is used for normal daylight movements. It is used whenever there is an adequate road network that is not overcrowded, when enemy detection is not likely, when time is an important factor, and when there is considerable travel distance involved. Vehicle interval in an open column is generally 100 meters.

a. Advantages of this method are -

- (1) It is the fastest method of march.
- (2) Reduced driver fatigue.
- (3) Improved vision on dusty roads.
- (4) Ease in passing individual vehicles.
- (5) Ease in dispersing vehicles as a passive defense measure against an air attack.

(6) Less chance of the entire unit being ambushed.

b. Disadvantages of this method are-

(1) Greater column length requires more road space.

(2) Other traffic often becomes interspersed in the column.

(3) Communication within the column is complicated.

5-4. Close Column

This method of movement is quite similar to the open column, except that the vehicle interval is less than 100 meters. At night each driver can observe the "cat's-eyes" of the blackout markers on the vehicle in front of him and maintain an interval of 20 to 50 meters (fig 5-1). If the driver sees two marker lights the interval is too great. If the driver sees eight marker lights he is too close. If the driver sees four marker lights he is maintaining the proper interval.

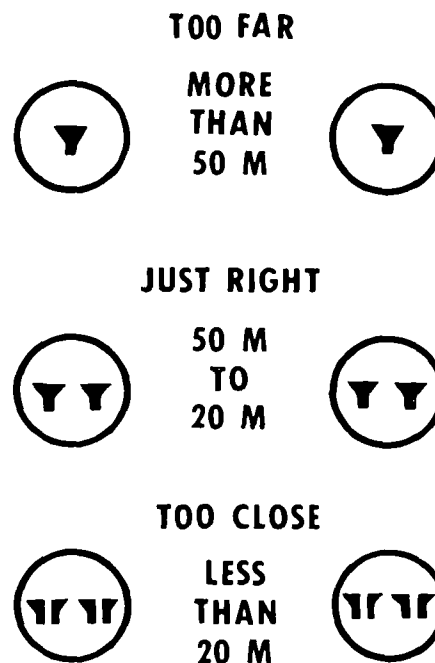


Figure 5-1. Cat's-eyes blackout markers.

During daylight the column is kept as compact as possible consistent with driving safety. The close column is used when there is a need for maximum command and control; e.g., during periods of limited visibility or when moving through built-up or congested areas.

a. Advantages of this method are -

- (1) It offers the most effective command and control.
- (2) Reduced column length.
- (3) Concentration of defensive firepower.

b. Disadvantages of this method are-

- (1) It is very vulnerable to enemy observation and attack.
- (2) Strength and nature of the column are quickly apparent to enemy observers.
- (3) Convoy speed is reduced.
- (4) Increased driver fatigue.

5-5. Infiltration

When the battery moves by infiltration, vehicles are dispatched individually or in small groups without reference to a march table. This technique is time consuming and the vehicles are difficult to control. It is used when the enemy has good target acquisition means and quick reaction capabilities. Whenever the battery mission requires stealth in moving to a new position, infiltration is the recommended method of movement.

a. Advantages of this method are -

- (1) It is the least vulnerable to hostile observation.
- (2) Ideal for covert operations.
- (3) Provides passive defense against air and artillery attack.
- (4) Deceives the enemy as to the size of the unit.

b. Disadvantages of this system are-

- (1) Time consuming.

- (2) Most difficult to command and control.

- (3) Small elements are more vulnerable to attack.

5-6. Terrain March

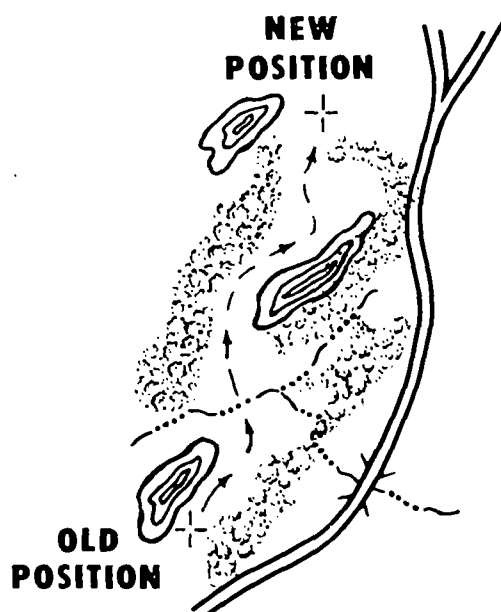
a. The terrain march is an off-road movement to reduce vulnerability of the battery and to avoid traffic tieups. The field artillery cannot afford to get caught in a traffic delay. A unit using this type of movement should travel close to tree lines, along gullies, and close to hill masses. A terrain march should be conducted when enemy observation or interdiction by artillery fire or air attack is likely. A battery may move safely on a road for some distance and change to a terrain march at a point where enemy observation becomes likely or vehicle congestion provides the enemy an inviting target.

b. The terrain march should be considered for traveling to alternate or supplementary positions. Careful consideration must be given to the following factors before any terrain march is conducted:

- (1) Displacement time may be increased.
- (2) Ground reconnaissance is required.
- (3) Soil conditions may complicate this type of movement.
- (4) Improper movement will leave wheel or track marks to the new position.
- (5) Extensive coordination is required to avoid traveling through other unit areas.

c. The battery employing the terrain march may move as a unit or by echelon. When it displaces by echelon, part of the firing element (possibly a platoon), a portion of the command and service element, and a portion of the FDC may move in the first echelon. The remainder of the battery may move in the second echelon. This and other combinations insure continuous fire support and can be used in split battery or other types of operations. A modification of this technique would be to move non-mission-essential vehicles (mess, maintenance, supply) with the battalion headquarters. These vehicles can

be moved in column or infiltrated to the battery position area at a later time.



5-7. Orders

The details given in a march order depend on the time, the tactical and traffic situations, and the completeness of the unit SOP. (In a fast-moving, hostile situation many orders will be verbal.) The order may be supplemented by strip maps, sketches, and march tables. The principal items that should be included in a march order are--

- a. Situation.
- b. Mission.
- c. Destination.
- d. Organization, to include order of march and composition of the column.
- e. Instructions to the air observer (when applicable), reconnaissance parties, and route marking and control groups. Instructions should include place and time of departure, mission, special instructions for communications, and the time of rejoining the main body.
- f. Instructions to the main body to include the start point (SP), control points (CP), and release point (RP) and times for arrival at and clearance of these points; rate of march; and the route.

g. General instructions regarding restrictions on use of roads, maximum speed of march units, catchup speeds, alternate routes and detours, and restrictions on use of lights and any special instructions regarding march discipline or defense against air or ground attack.

h. Communication instructions regarding the use of radio, messengers, flags, whistle or horn signals, pyrotechnic signals, and hand and arm signals.

5-8. Organization of the Column

The organization of the battery column varies according to the tactical situation, the threat, and the position area to be occupied. The following points should be considered:

- a. In areas where enemy attack is probable the cannons should be dispersed throughout the entire column.
- b. The column should be organized so that the lead vehicle will occupy the deepest position in the new area.
- c. If feasible, there should be two air guards per vehicle. One scans the sky forward of the vehicle while the other scans the sky rearward.
- d. Machineguns should be distributed evenly through the column and should be aimed alternately to the left and right sides of the route of march.
- e. Canvas should be removed to allow personnel to have their individual weapons poised to return fire if attacked. Individuals riding on the left side of a vehicle fire to the left; those on the right side fire to the right.
- f. Key personnel should be dispersed throughout the column to preclude losing a disproportionate number of these persons as a result of enemy action.

5-9. Loading Plans

a. A loading plan prescribes efficient loading of personnel and equipment for movement. Each vehicle should have one. Loading plans are particularly important in sustained combat. Soldiers get tired and inattentive. They lose things. A good loading plan is insurance that a unit will close into

the new position with all its equipment. The loading plan for a vehicle must be such that the equipment most essential to the mission will be loaded last. The loading plan should be recorded and graphically portrayed. Use of the loading plan is an indicator of training, discipline, and esprit de corps. If a loading plan is not prepared or specified by battalion headquarters, each battery should prepare its own. Personnel responsible for devising loading plans should consider the mission, personnel, SOP, and equipment of the battery. Steps in preparing the loading plan include-

- (1) Examining the battery table of organization and equipment (TOE) to determine the personnel, equipment, and vehicles authorized for each section.

- (2) Examining all non-TOE property that must be transported by the battery. This equipment should be carried by the section responsible for its use.

- (3) Listing the personnel and equipment to be carried in each vehicle. Equipment should be located to facilitate identification under blackout conditions.

- (4) Conducting practice loadings to test the validity of the loading plan and adjusting the procedures if necessary.

- (5) Establishing a list of the items that must be removed from the vehicle and carried forward if the vehicle becomes disabled during movement.

b. The unit should habitually load all TOE equipment during training. Equipment that is not essential to job performance or not frequently used should be left loaded. The more equipment left loaded, the less loading time required and the less likely equipment will be lost during movement. (A place for everything and everything in its place.)

5-10. Convoy Control Measures

The following control measures assist in the movement of the battery.

a. *The start point (SP)* is normally a geographical feature identifiable on the ground and on a map. The first vehicle of a battery

convoy must cross the SP at the specified start time. The battery is responsible for determining the route to the SP and the time it will take to get there. If the battery is displacing as part of a battalion move, the SP is also the point at which control of the marching element is normally assumed by the battalion.

b. *A check point (CP)* is normally a geographical feature identifiable on the ground and on a map. It is used in reporting progress along the route of march.

c. *The release point (RP)* is normally a geographical feature identifiable on the ground and on a map. The last vehicle of a battery convoy must cross the RP at the specified time. The battery is responsible for determining the route from the RP to the new position area. If the battery is displacing as part of a battalion move, the RP is also the point at which control of the marching element is regained by the battery. The BC may send a vehicle from the reconnaissance party to the release point to lead the battery into the new position area.

d. *Route marking aids in the move.* The route-marking detail marks the route by posting signs and/or personnel at those critical locations where elements of the march might make a wrong turn. Provisions are made to insure the prompt pickup of the route markers/guides when they are no longer needed. Details concerning traffic control and route marking are presented in FM 55-30, and FM 19-25.

5-11. March Discipline

a. Officers and noncommissioned officers ride where they can best control and supervise the march of their units. They usually ride where they can control the vehicle driver. The senior person in each vehicle is responsible for insuring that all orders concerning the march are carried out. In order to supervise the move, commanders and other designated personnel may require their vehicles to pass other vehicles in the column. All other vehicles maintain their positions until otherwise directed or until circumstances dictate otherwise.

b. The column must keep moving. The unit SOP should indicate who stops to pick up mission-essential personnel and equipment if a vehicle breaks down. In most cases, the driver stays with the vehicle and the maintenance section stops to assist. If the disabled vehicle cannot be repaired in a reasonable time or recovered by the battery, the position and condition of the vehicle are reported to battalion for recovery. The maintenance section must be prepared to proceed along the route of march independently as soon as possible in order to be available to the remainder of the battery. Accordingly, the maintenance section must have a map and must be thoroughly briefed concerning the route of march.

c. Each vehicle commander is responsible for watching for signs, markers, signals, and other traffic. He is also responsible for insuring that the driver is alert at all times.

d. March discipline is attained through training and through internal control within the marching unit. The specific objective of march discipline is to insure intelligent cooperation and effective teamwork by march personnel. Teamwork includes--

(1) Immediate and effective response to all signals.

(2) Prompt relaying of all signals.

(3) Obedience to traffic regulations and to the instructions of traffic control personnel.

(4) Use of cover, concealment, camouflage, dispersion, radio listening silence, blackout precautions, smoke, and other protective measures against air, ground, armor, or chemical, biological, and nuclear attack.

(5) Maintenance of correct speeds, positioning, and intervals between vehicles within the column.

(6) Ability to recognize route marking signals/signs.

(7) Use of correct procedures for handling disabled vehicles.

5-12. Halts

a. During administrative marches, halts are made at regular intervals or at selected

sites to rest personnel, to service the vehicles, and to check the loads. Halts are not normally scheduled for tactical marches.

b. During an extended vehicle march (1 or 2 days) from a communication zone (COMMZ) to a battle area, wooded areas and winding roads should be selected as halting places, since they provide concealment and do not present a straight line of vehicles for attack by enemy aircraft. During extended marches, halts should be made where vehicles can be dispersed off the road. Crossroads, railroads, and other similar places should be avoided. A column should be halted in an area that provides a 200-meter clear view of approaching traffic at each end of the column.

5-13. The March Column Under Artillery Attack

The immediate action in defense against hostile artillery fire is to *move out of the danger area*, report the situation to higher headquarters and request immediate counterfire. If a battery expects hostile artillery fire during the march, it can reduce its vulnerability by--

a. Moving by open column or infiltration.

b. Moving under the cover of darkness or during other periods of reduced visibility.

c. Moving by terrain march.

5-14. The March Column Under Air Attack

In the event of an air attack, the battery should engage the aircraft immediately with all air defense weapons available in the column and simultaneously disperse off both sides of the road and halt. A high-performance aircraft cannot be effectively engaged by leading it with small arms fire. As the aircraft approach, all individuals fire their weapons in the air to form a wall of bullets through which the aircraft must fly. For a detailed discussion of individual engagement techniques see TC 23-44. Your Redeye section should have a copy.

5-15. Roadblocks

If the battery is halted by a roadblock, it should use such force as is necessary to clear the roadblock, including direct or indirect fire by the howitzers, pre-planned suppressive fires, and concentrated fire by available automatic weapons. An attempt to crash through roadblocks with vehicles before it is checked for mines may result in unnecessary loss of equipment and personnel and a complete blocking of the road by disabled vehicles.

5-16. Ambush

a. There are two types of ambushes--blocked and unblocked.

(1) *Blocked ambush.* If the route is blocked, maximum available fire should immediately be placed on the attacking forces. Personnel in the kill zone should immediately *dismount* and *attack* as infantry. Staying in the kill zone is the worst thing you can do. The portion of the battery that is not in the kill zone must also *REACT IMMEDIATELY*. There are few ambushing forces that can equal the organic firepower of an artillery battery. *USE THE HOWITZERS* to place direct or indirect fire on the ambushing force (this should be SOP so that there is no delay while awaiting orders). Then roll up the flank of the ambushing force.

(2) *Unblocked ambush.* In an unblocked ambush, the battery should increase its speed and move through the ambush area while placing the maximum amount of small-arms and automatic weapons fire on the attackers.

b. A consideration in employment of the howitzers main armament from the kill zone is that the targets may be too close for proper fuze action. Only the APERS (Beehive) round has a muzzle action capability.

c. If the area was identified during the map inspection as a likely ambush site, call in preplanned suppressive fires. Otherwise, immediately send a fire request to your supporting unit.

d. If the ambush or any other enemy action is of such magnitude as to cause the column to be broken up, individual elements

should proceed to the new position or designated rally points on their own.

5-17. Training

a. Training in convoy operations and counterambush measures should conform to the unit SOP. This will help insure that personnel are adequately trained to cope with situations that may confront them. Some considerations for establishing a training program are--

(1) Establish a realistic movement SOP. It should conform to battalion SOP and cover, as a minimum, the following:

(a) Approval authority for displacing the battery.

(b) Duties of convoy commanders.

(c) Convoy organization.

(d) Weapons and ammunition to be carried.

(e) Hardening of vehicles.

(f) Protective equipment to be worn by personnel.

(g) Preparation of vehicles (detailed instructions regarding tarpaulins, windshields, and tailgates).

(h) Counterambush action.

(i) Drills in reaction to air or artillery attack.

(j) Security measures.

(k) Maintenance and recovery of disabled vehicles.

(l) Any scheduled refueling and/or rest halts.

(2) Stress estimating and maintaining the specified interval between vehicles especially if the column halts. Put interval marking signs on your motor pool exit to assist drivers in training.

(3) Teach the drivers to habitually evaluate the terrain in light of the cross-country mobility of their vehicles. Even in a well-developed area with a good road net, a driver may be required to make an off-road detour to bypass a roadblock or a section of damaged

highway. The habit of constant terrain evaluation enables him to make a quick decision and promptly select the most practical route.

(4) Practice terrain movement in small elements.

(5) Practice en route immediate action and critique it on the scene. Include vehicle breakdowns, equipment transfer, and vehicle repair/recovery in this action. (Many items in this area can be committed to your SOP.)

(6) Practice blackout movements to acustom the drivers to using the blackout lights. As they become proficient, restrict them to cat's eyes only.

b. Here are some tips for increasing the battery capability to conduct rapid and secure tactical vehicle marches--

(1) Do not limit training to those times when the entire battery is available. Whenever two or more vehicles are going to the same destination, conduct the movement as a tactical march.

(2) Find out how fast the battery can travel, both on and off the road, without losing the slowest vehicles. (Putting the slowest vehicles up front will automatically pace the column.)

(3) As a planning guide, on roads and trails the battery will average 25 km per hour in an open column and 10 km per hour in a close column (at night).

5-18. Miscellaneous

Detailed descriptions of the various other types of movements and marches (administrative, etc.) are given in the following manuals:

a. FM 55-30 and FM 55-31 include information on the organization of motor movements, the movement of personnel, and the planning of motor movements.

b. FM 100-(), Nuclear Unit Operations in Combat.

c. FM 101-10-1 includes planning guidance for movements.

5-19. Movement By Rail, Air Or Water

When the battery moves by rail, air, or water, it normally moves as an element of the field artillery battalion or with a supported unit. In any case, the battery receives detailed instructions in the form of a movement order or pertinent extracts from the movement order. A warning order alerts the battery and furnishes sufficient information of the impending movement for the battery to make plans and take the necessary preliminary action. The references listed below provide adequate information for the following types of movements:

a. Movement by rail--FM 101-10-1 and FM 55-15.

b. Movement by air--FM 1-100, 57-35, 61-100, 100-27, 101-10-1 and TM 55-450-15.

c. Movement by water--FM 101-10-1 and FM 55-15.

5-20. International Standardization Agreements

a. *STANAG 2041*, Operational Road Movement Orders, Tables, and Graphs. When the US Armed Forces operate with NATO Armed Forces, the instructions in *STANAG 2041* will be followed. The applicable details of this agreement and instructions are contained in FM 55-30 and FM 61-100.

b. *STANAG 2154*, Definitions and Regulations for Military Motor Movements by Road. When US Armed Forces operate with NATO, SEATO, and CENTO Armed Forces, the instructions given in *STANAG 2154* will be followed. This *STANAG* is explained in FM 55-30 and FM 61-100.

c. *SEASTAG 2024*, Military Road Traffic Lighting Regulations. When US Armed Forces operate with SEATO Armed Forces, the instructions in *SEASTAG 2024* will be followed. Additional instructions are found in FM 6-36 and FM 19-25.



CHAPTER 6

OCCUPATION OF POSITION: THE "O" OF RSOP

6-1. General

a. The manner in which the position is occupied depends on the reconnaissance party and the movement techniques used as well as on the type of occupation itself. This chapter treats three types of occupation--deliberate, hasty, and emergency. Additionally, the key functions performed in laying and readying the battery for firing and for sustaining operations are addressed.

b. A *DELIBERATE* occupation, as the term implies, is one that has been planned. A reconnaissance party precedes the unit and prepares the position in advance. The occupation may be during daylight hours following a daylight preparation, at night following a daylight preparation, or at night following a nighttime preparation. A common error in a deliberate occupation is allowing too much activity during preparation, thereby risking compromise before the position is ever occupied. As a general rule, the number of vehicles allowed to go forward should be severely restricted. When the tactical situation allows, a very good method of occupying a new position is to perform the reconnaissance prior to darkness and the movement at night. Nighttime movement following a nighttime reconnaissance is often necessary, but it is very time consuming.

c. The *HASTY* occupation allows little or no time for reconnaissance and advance preparation. It differs from the deliberate occupation mainly in the amount of time available for reconnaissance and preparation. It generally results from unforeseen circumstances and highlights the importance of the BC planning ahead and selecting tentative positions and routes to them.

d. The *EMERGENCY* occupation, long known as the *hip shoot*, should be avoided if at all possible. It represents either a failure in planning or an unforeseen and likely catastrophic situation. However, the battery should be trained in emergency occupation techniques. There will be no advance pre-

paration and the procedures for occupation will be far more decentralized.

e. The remainder of this chapter will be devoted to the key elements of the actual occupation. Details on defense of the battery position and the sequence for position defense improvement are contained in chapter 7.

6-2. Deliberate Occupation

a. A guide meets the battery at the release point (RP). The guide conceals himself in the vicinity of the RP and exposes himself only to gain the attention of the XO. This guide leads the battery to the entrance of the position area where the vehicle guides are waiting to lead each vehicle to its selected location.

b. A gun guide positions the self-propelled howitzer so that the left edge of the howitzer is parallel and very close to the guide stakes. The guide stakes are aligned on the azimuth of fire. A towed howitzer is positioned on the line of fire and stopped with the sight mount over the pantel marking stake.

c. The gun guide announces the deflection to the aiming circle to the gunner. The guide obtained this deflection during the preparation for occupation.

d. The telephone of the howitzer is connected to the communication wire (when available) that was laid from the SB-16 during the reconnaissance.

e. The XO/GSG uses a phone connected to the SB-16 in laying the weapons. This is most important in SP units because the howitzer engines can be left running and proper cooldown procedures can be followed. As time permits, the XO verifies the lay with a second aiming circle.

f. The 1SGT directs the augmentation of the security and defense of the battery area as personnel become available.

g. After the maintenance section has been positioned, has camouflaged its equip-

ment, and has prepared its portion of the defensive position, the motor sergeant or a mechanic should contact the section chief or drivers of each section to determine any maintenance needs resulting from the move. The BC and XO should be informed of any major problems and the estimated time needed to correct the faults.

h. Additional considerations for night occupations are--

(1) *Light discipline.* Adequate preparation for a night occupation should minimize the need for lights. Vehicle lights should be turned *OFF* as soon as the ground guide has begun leading the vehicle into position.

(2) *Noise discipline.* Noise can be heard at greater distance at night.

(3) *Time requirement.* The time for occupation is greatly increased.

(4) *Prearranged signals.* Filtered flashlights should be used to gain the attention of the XO at the RP.

(5) *Each vehicle guide should know where his vehicle is in the order of march.* This will enable the battery to move smoothly into position without halting the column while guides attempt to identify their vehicles.

(6) *Filtered flashlights are used to lead the vehicles.* Each driver must be cautioned to **STOP HIS VEHICLE WHENEVER HE CANNOT SEE THE LIGHT FROM THE GUIDE'S FLASHLIGHT.**

(7) *Vehicles should not be allowed to move within the position without a guide.*

6-3. Hasty Occupation

a. In a hasty occupation, day or night, the battery will require more time to occupy the position, as some preparatory tasks cannot be performed during the limited time available for the reconnaissance and selection phase. This may result in--

(1) Delay in getting the vehicles off the route of march into the position area.

(2) Laying by voice in towed units.

(3) Increased laying time, since gun guides might not have aligned the stakes on the azimuth of fire.

b. When the reconnaissance party has to prepare a new position at night, the procedures for deliberate occupation at night are used, but less time may be available and fewer tasks may be performed.

6-4. Emergency Occupation

a. At times an emergency may require the battery to provide immediate fire support while moving. In this situation, the XO plots the target on his map, selects a position, and by prearranged signal notifies the remainder of the battery. The XO positions his vehicle on battery center and orients it on the azimuth of fire so it can be used as a guide by the howitzer sections moving into position. Firing data is computed either by the XO or the FDC (the FDC should have received the mission and already have the target location). As the data is being computed, the XO/CFB lays the first piece that is ready. He uses either the aiming circle, the aiming point-deflection, or the howitzer back-lay method (chapter 9). As soon as a single weapon is laid, the XO or FDC is notified so that adjustment of fire can be initiated.

b. Unit SOP should dictate how the howitzers and service vehicles disperse. Drivers should be drilled in this procedure to the point that they can act totally without commands. If the tactical situation requires the battery to remain in position after completion of the emergency mission, the vehicles should be tactically dispersed and the position prepared accordingly.

c. When the battery receives an emergency mission at night, the XO has to decide whether to occupy some position along his route or to proceed to the newly prepared position and accomplish the fire mission from there. The battery may be able to respond faster and more accurately from the new position area.

d. An effort should always be made to avoid a situation which requires a battery to pull off the road and execute an emergency

mission. Where possible, another unit already in position should fire the mission. The technique, however, provides a valuable training vehicle to instill and practice the need for speed, accuracy, and enthusiasm. It represents a skill in the artilleryman's trade that all batteries should be capable of performing.

6-5. Sustaining Actions

a. The training and teamwork of the unit in performing the RSOP will culminate with the battery ready to provide timely fires in a minimum amount of time after moving.

b. Once the occupation is completed and the battery is ready to answer calls for fire, sustaining actions begin. They are continuous until the position is vacated. These actions include completing the position defense and those actions necessary for the battery to

remain and fire from the position for an extended period of time. These actions include but are not limited to--

- (1) Camouflage improvement.
- (2) Hardening of critical elements.
- (3) Maintenance.
- (4) Refueling.
- (5) Resupply of ammunition.

c. Care must be exercised in the manner in which ammunition resupply and refueling are conducted, particularly in SP units, for they can reveal the location of the battery. If possible, the tasks should be accomplished at night.

d. Members of the reconnaissance party should *always* be prepared to leave at a moment's notice.



CHAPTER 7

DEFENSE OF THE BATTERY AREA

Section I. INTRODUCTION

7-1. General

Success on the battlefield by the combined arms team depends on the ability of the team to effectively maneuver with timely, accurate and responsive fire support. Because fire support is critical to success, the field artillery will be the target of intensive counterfire, tactical airstrikes and ground attacks directed toward destroying or neutralizing the fire support means of friendly forces. If we are to provide the required fire support, we must first survive in this hostile environment. Survival will be accomplished only by honing to a fine edge the capability of the battery to hide and, if necessary, defend itself. Successful camouflage and self-defense can be accomplished only by sound planning, intensive training, and vigorous execution.

7-2 Responsibilities

a. Whether the defense is active or passive, basic fundamentals of defense apply. Planning, preparing, rehearsing and position hardening are the cornerstones of defensive operations in the battery area. Planning, coordination, and control are the responsibility of the battery commander; however, the first sergeant is the real defense manager. He prepares, rehearses, and directs execution of the final plan.

b. When formulating the plan, the 1SG considers the potential threat force, the unit personnel status, and the time available to determine the type and extent of defensive positions to be prepared. He prescribes the final location for crew-served and antitank weapons, defines fields of fire, locates observation and listening posts, and recommends supplementary howitzer positions for defense of the battery.

c. The first sergeant coordinates closely with the XO in selecting targets and sectors for the employment of the howitzers in defense of the battery. The employment of HE shell with PD fuze on point targets, HE and

WP shells with fuze time, Killer Junior techniques (shell HE, fuze time fired at the lowest possible charge) and smoke, Beehive, and ICM for 6,400-mil coverage of the battery should be considered. After coordination of the targets for the howitzers, the XO determines individual firing data for each section and provides these data to the FDC and to each section. The employment of the cannon in defense of the battery is shown on the defense diagram.

d. The 1SG must also insure that the communications required to support the plan are installed, checked, and functioning properly. After he develops the battery defense plan, the 1SG should have the plan checked by the battery commander at the first opportunity. However, preparation of the position should not be delayed until the battery commander's approval is obtained. Once position preparation has begun, the first sergeant supervises continuous improvement of the positions and reinforcement of the plan. He also insures that the small-arms and crew-served weapons ammunition resupply plan is prepared and fully understood by all.

7-3. Terrain

The primary consideration in selection of a firing position is accomplishment of the mission. The defense plan must take maximum advantage of the available terrain. Here are some fundamental terrain considerations.

a. *Key terrain* must be occupied or denied the enemy. Retention of key terrain offers an advantage to either combatant. If occupation is not feasible, key terrain must be covered by fire and observation.

b. *Avenues of approach* for both dismounted and mounted attacks must be covered by fire with predetermined kill zones. Air avenues of approach will probably be along the linear axis of the battery or down the natural lines formed by valleys or ridge-

lines. Consideration should be given to positioning air defense resources, to include Redeye, on the flanks of the battery or at the entrances to a valley. Each FA battalion is authorized one Redeye section, consisting of three or more Redeye teams. A team consisting of two personnel, a 1/4-ton vehicle with radio, and Redeyes is normally attached to each cannon battery. In addition to providing early warning of, and defense against an air attack, the Redeye team can also be used as one of the battery observation posts to provide early warning of a ground attack (see paragraph 7-4).

c. *Good observation* provides information and aids in early warning. It precludes surprise and should be coordinated within the unit and between adjacent units when possible.

d. *Fields of fire* are necessary to cover avenues of approach into a position area in order to destroy the enemy and break his assault.

e. *Obstacles* are used to delay, stop, divert, or canalize an attack force. Time and material available will dictate the degree of construction of manmade obstacles. Maximum advantage must be taken of *natural* obstacles. Types of manmade obstacles and techniques for their employment are found in FM 5-15.

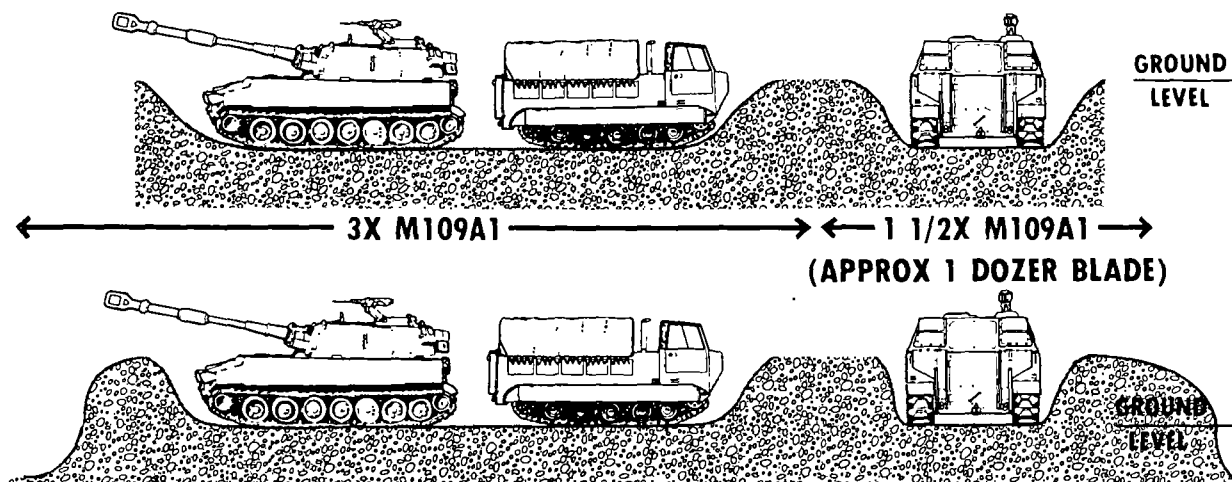
f. *Cover* provides protection from the effect of weapons fire. Both natural and manmade objects can be used. *Maximum* advantage

of natural cover must be taken, as time will not normally permit elaborate position hardening. In fast-moving situations, hardening is often limited to digging foxholes on the perimeter, burying wire, constructing shelters for prone individuals, and placing sandbags around sensitive equipment such as collimators and tires. Individual shelters must make maximum use of natural cover and obstacles of the terrain. If no natural cover is available, the parapet foxhole (PAR-FOX) should be constructed with a parapet angle of at least 45°. Further information on the PARFOX is contained in TC 7-50.

(1) Priority in hardening the position should be given to -

- (a) Collimators
- (b) Wire
- (c) Ammunition
- (d) Personnel
- (e) Howitzers and FDC
- (f) BOC
- (g) Tires of wheeled vehicles

(2) If available, engineer equipment can be a big help in hardening the SP position. An experienced dozer operator can provide a suitable position, either dug in or bermed up, in a short time. Such a position should be long enough to permit the M548 ammunition vehicle to occupy the same position as shown below.



(3) The commander must exercise caution when hardening a position in this manner. The dirt spoil and dozer tracks must not be allowed to destroy the camouflage effort. FM 5-15 contains good examples for hardening the towed weapon position.

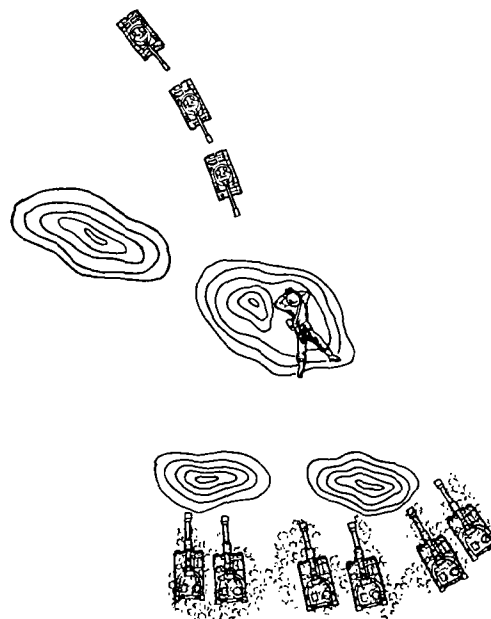
7-4. Establishing and Maintaining security

The cannon battery is highly vulnerable to attack during the time it is occupying a new position. The first order of business in establishing a defense must be to provide early warning for the battery. Initially, this will most likely consist of establishment of observation and listening posts. The security system is then refined as time permits.

Early warning provides the reaction time the commander needs to decide whether to avoid the threat by moving or to fight from predesignated defense positions. Techniques and methods for providing security are --

a. Intelligence channels. Higher headquarters and adjacent units can provide information about enemy activities that threaten the cannon battery. In addition, forward observers, fire support officers and information gathered from the battalion command fire net can provide warning of impending attack.

b. Observation and listening posts. These must be positioned a sufficient distance from the battery to provide early warning and time to react to the threat. The distance depends on visibility, the closing speed of the enemy and the extent to which the terrain masks the position from direct fire weapons. Observation posts (OP) and listening posts (LP) must cover avenues of approach. Several may be required to provide full coverage.



Listening posts augment observation posts when visibility is reduced and fill gaps when OP's are withdrawn at night. LP's and OP's should be withdrawn when engagement is imminent. Each OP and LP should be manned by at least two men and each location should have a primary and alternate means of communication.

c. Early warning devices. These can range from rocks in tin cans and trip flares to sophisticated electronic anti-intrusion devices and can supplement LP's and OP's. Unattended ground sensors should be placed forward of OP's and LP's, particularly in areas not visible from the posts. Types of unattended ground sensors and techniques for their employment are found in FM 31-100.

Section II. ORGANIZATION OF THE DEFENSE

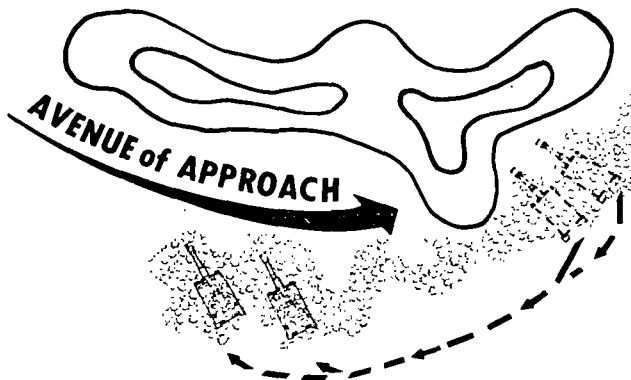
7-5. General

Defensive operations should be planned so the battery commander will be warned of an impending attack in sufficient time to displace his unit or to defend the position. In either case, the defense must protect the unit against air, armor, and infantry attack from

all directions. When establishing a perimeter defense it is critical to coordinate with adjacent units to provide mutual support and to preclude firing into a friendly position. The defense can best be described as having three elements.

a. *The long-range element* is intended to provide observation along likely avenues of approach and to provide advance warning to enable the BC to implement his defensive plan. This portion of the defense involves the use of observation posts and the receipt of intelligence information.

b. *Supplementary positions* are the positions from which the unit can best accomplish a mission that cannot be accomplished from the primary position or from which it can defeat or stop the enemy outside the battery perimeter. Weapons such as the Dragon and LAW with complementing machineguns and, in some instances, a cannon platoon or the M548 ammunition carrier can be employed at these positions. The 50-caliber machinegun can be ground mounted to increase the firepower and security of the supplementary positions. Support of the supplementary positions could consist of such items as planned indirect fires and natural and manmade obstacles.



c. *For perimeter defense* the close-in defense plan is prepared by the first sergeant and is designed to protect against ground attack and as the final protection against armor. During the hours of darkness, early warning devices must be so employed as to give a reaction force enough time to deploy.

7-6. Defense Against Armor

a. *If cannons* must be employed against armor, at least a platoon should be deployed. This platoon should engage the tanks from supplementary positions outside the battery area. Kill zones should be designated, and the weapons should be fired in sequence. An

artillery cannon should be used in a direct fire role against armor only in *extreme* circumstances.

b. *Tank-killer teams* are small groups of personnel (usually four to six) who are especially proficient in the use of antitank weapons, mines, and field expedients. They must be trained in the capabilities and identification of enemy armor, methods of engagement, and techniques for destruction of armor. The teams are deployed in a defensive role *only* and add a physical and psychological advantage to the battery antiarmor capability. Anti-armor weapons positions and kill zones should -

(1) Be outside the battery area to prevent the armor from firing directly into the battery area.

(2) Have a primary position and a series of alternate positions. Because of the backblast signature of the LAW and DRAGON, only one round per weapon should be fired from each position, since the tank will probably return fire with its main gun. A covered and concealed entrance/exit route to each position enhances the survivability of the operator.

(3) Allow 90° flanking fires on armor avenues of approach, since the sides and rear of a tank are the most vulnerable.

(4) Allow antiarmor weapons to be deployed in pairs as a minimum. This deployment allows continuous engagement through sequential firing and mutual support among antiarmor weapons. Firing in pairs and in sequence also greatly enhances the probability of killing a tank.

(5) Be designated within the maximum effective range of each weapon (LAW--200 meters, DRAGON--1000 meters). If time permits, range cards similar to the howitzer range card may be prepared for each position.

7-7. Establishing Priorities

The greatest threat posed by the enemy must be given priority in establishing the defenses. The BC and first sergeant should consider each threat, how critical it is, and the time available and then decide which tasks must be accomplished and in what order.

7-8. Flexibility

As an attack develops, many unanticipated circumstances can arise. The battery must be able to shift its defensive resources or cover its withdrawal. The unit SOP should provide guidance for the evacuation of a position area under emergency conditions. Methods of increasing flexibility are--

a. Formulating contingency plans. Contingency plans answer the "what if" questions concerning possible enemy actions or reactions to the battery's initial defensive posture.

b. Training for immediate action. The BC must insure that all personnel are trained to react to situations without delay. They must be rehearsed to react, without instructions, to various types of enemy attack, such as--

(1) *Air attack.* Air defense resources are manned. Personnel disperse, take cover, and return fire with small arms and automatic weapons. Weapons should be fired straight up to form a wall of bullets through which the aircraft must fly. The important thing is that everybody shoots. If a Redeye team is attached to the battery, it should be employed in conjunction with the OP's. Advance warning by the Redeye team increases the chances of deterring an attack from the air (for training in these techniques, see TC 23-44).

(2) *Ground attack.* Personnel will man predesignated defensive positions on the perimeter. Machineguns are located to provide final protective fires, howitzers are prepared to engage targets in predesignated sectors of direct fire, and the reaction force is assembled. Planned defensive targets should be established and coordinated through battalion headquarters for mutual support of other firing batteries within range.

(3) *Artillery attack.* Personnel take cover. Consideration should be given to manning the defensive perimeter in the event of a coordinated artillery and ground attack. Whenever and wherever hostile cannon, missile, or mortar shelling is detected, it must be reported without delay to the appropriate S2 (intelligence officer) who can evaluate

and act upon such information. Taking the initiative early is paramount to success. When our counterfire agencies are provided with sufficient information, immediate operational objectives can be obtained to insure the successful attack on hostile weapons. Shelling reports (SHELREP) are essential for effective counterfire action. The most reliable, accurate, and informative shelling reports are the result of visual or electronic observation supplemented by crater analysis and fragment identification. Each battery should have a SHELREP team that can perform a crater analysis and fragment identification quickly and accurately. Remember, the sooner this information is forwarded to higher headquarters the sooner counterfire can be initiated. (Detailed information is contained in FM 6-121.)

(4) *Nuclear and chemical attack.* For appropriate discussion of defensive measures, see FM 21-40. Refer to STANAG 2047 (appendix H) before developing standard warning signals for chemical or nuclear attack.

c. Establishing a reaction force. This force is drawn from various sections of the battery to insure that no one section is depleted to the point that it is incapable of performing its primary mission or covering its portion of the perimeter. An alert must be arranged and an assembly area designated. This force is designed to--

(1) Reinforce a threatened portion of the perimeter.

(2) Eject small groups penetrating the perimeter.

This reaction force should *not* pursue beyond the perimeter and must be thoroughly briefed before employment. When one reaction force is employed, an alternate force should be assembled. Reaction forces must be well rehearsed to insure speed and teamwork.

7-9. Defense Diagram

Upon occupying a position, each section must have a predetermined sector of respon-

sibility that makes maximum use of the section's main armament. As soon as practical, the BC/ISG should evaluate the defensive plan by studying the defense diagram.

The defense diagram is a sketch, drawn to scale, of the battery defensive resources and is based on the data from each howitzer and machinegun range card. It includes the fields of fire for other weapons such as grenade launchers, antitank weapons, and individual weapons. The diagram is prepared by the ISG and approved by the battery commander. A copy is provided to the battalion XO.

a. Equipment required. In order to construct the defense diagram, you must have a 1:50,000 map of the area, a coordinate scale, a protractor, overlay paper, and a blank 1:25,000 grid sheet.

b. Construction of the matrix--

(1) Locate the battery center on the 1:50,000 map. Identify the grid square or squares that contain the terrain features that influence the defense of the battery position.

(2) Place tick marks at 200-meter intervals along the sides of the selected grid squares (fig 7-1).

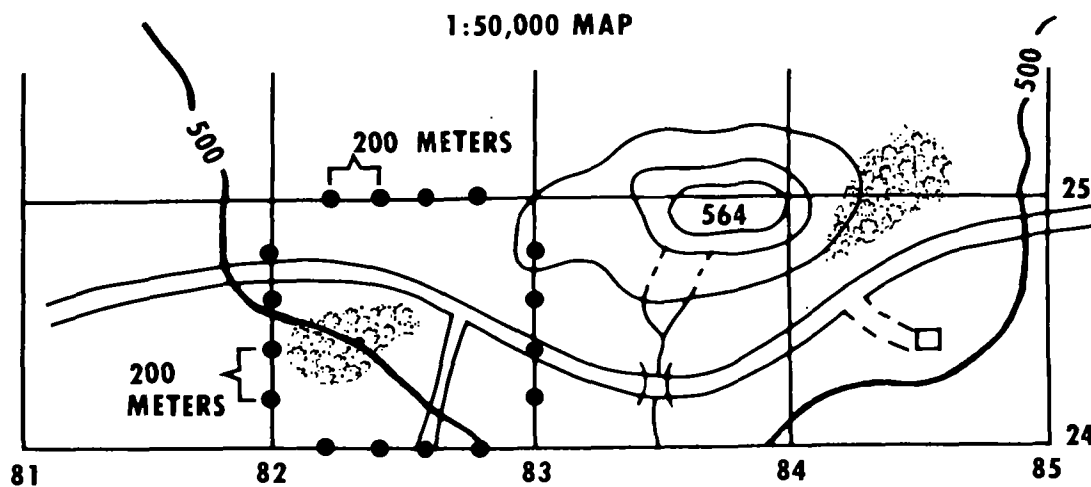


Figure 7-1. Tick-marking grid square.

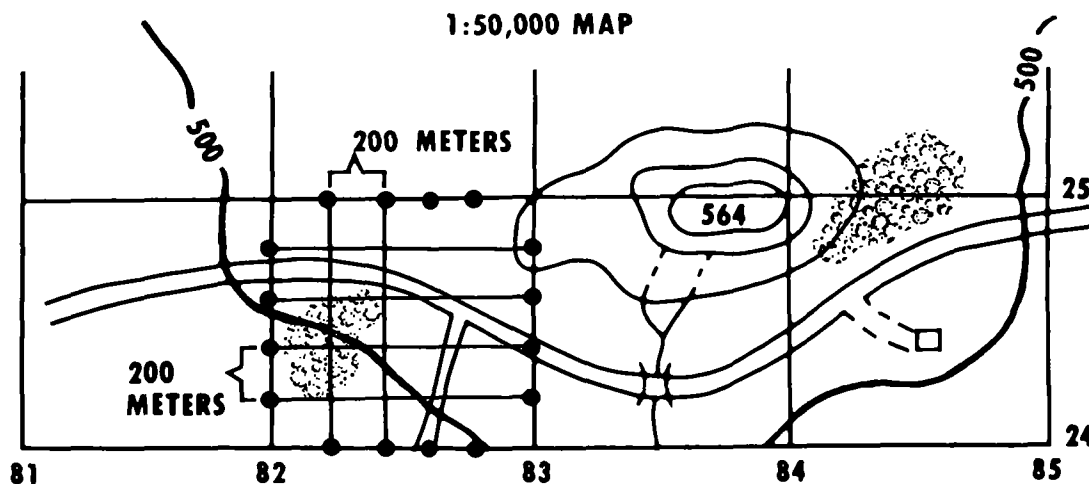


Figure 7-2. Forming the matrix.

(3) Connect the tick marks to form 200-by 200-meter squares within each grid square (fig 7-2).

(4) Label the squares beginning at the lower left of the grid square. Number the

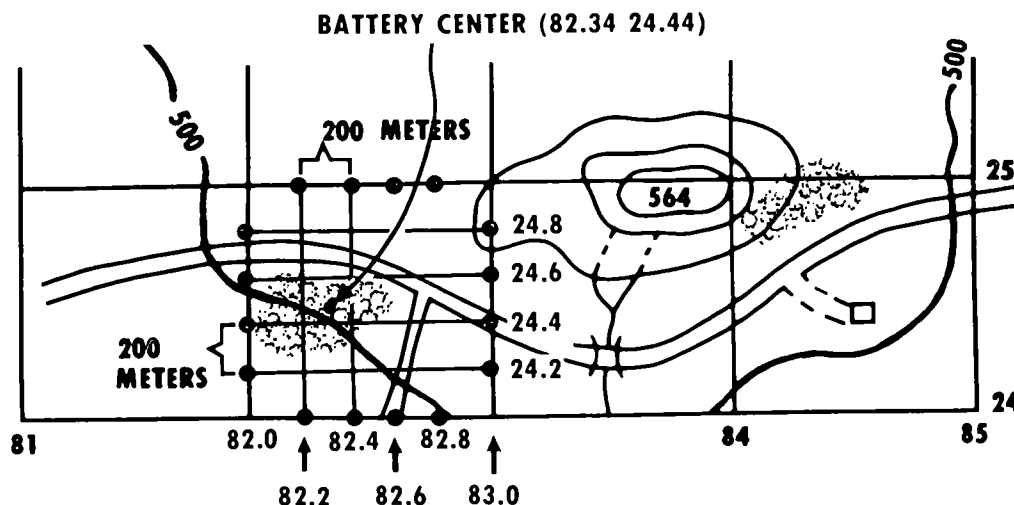


Figure 7-3. Labeling the matrix.

lines to the right and up, as you would read a map (fig 7-3).

(5) Expand the scale to 1:5,000 by using a blank 1:25,000 grid sheet. In expanding the scale to 1:5,000, each 200-by-200-meter block within the matrix correlates with a 1,000-meter grid square on the 1:25,000 grid sheet. Determine which 200-by-200-meter block on the matrix contains the battery center. In figure 7-3, it is 82.2 24.4. Next, select a square near the center of the center of the blank grid sheet, label this square the same—82.2 24.4. You have identified and labeled the 200-

by-200-meter block where the battery center is located. From this point, duplicate the labeling from the matrix on the grid sheet.

(6) Reproduce key terrain. Examine the 200-by-200-meter blocks on the 1:50,000 map that contain key terrain features that influence the defense. Sketch what you visualize in these blocks on the corresponding squares of the 1:5,000-scale grid sheet. The result will be a map reproduction minus the contour lines and other data not pertinent to the defense of the battery. However, contour lines representing hills or depressions may be included if they are deemed pertinent (fig 7-4).

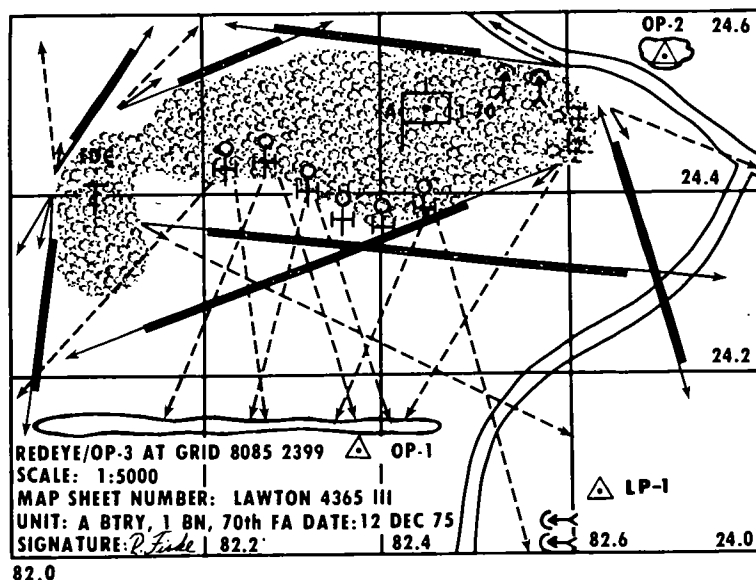


Figure 7-4. Completed Defense Diagram.

c. *Plotting on the diagram.* Use the coordinate scale to plot coordinates and to measure distance on the 1:5,000-scale grid sheet by dividing the indicated graduations on the coordinate scale by 10; e.g., the 1,000-meter graduation is read as 100 meters. Use the protractor for measuring azimuths or direction.

(1) Using the coordinate scale, plot the battery center on the 1:5,000 scale grid sheet. Construct a light line indicating the azimuth of fire. Next, draw a light line perpendicular to the azimuth of fire. Insure that this line crosses battery center. These two lines are used for orientation in direction; i.e., right, left, forward, and rear of the battery center. (Once you have completed the diagram, you may erase these lines.)

(2) Plot the weapon locations and sectors of fire. The following sources are available to assist in this task:

(a) *Machinegun range cards* indicate the location (distance and direction from battery center or other known point) and the azimuths of the left and right limits and/or final protective line (FPL). The range card is prepared for all crew-served weapons. It is a record of firing data necessary to engage preselected targets within the sectors of fire during periods of limited visibility. The range card may also be used as a reference to engage targets and to aid in the preparation of the defense diagram. Details on preparing machinegun range cards are in FM 23-67.

(b) *Cannon range cards* indicate azimuths of the left and right limits. In addition, they should show key terrain features as well as predesignated targets with firing data. The range card should consist of two parts--a sketch of the sector(s) of fire containing targets and reference points and a data section that lists data necessary for engaging targets during periods of limited visibility. The format shown in figure 7-5 is recommended for a howitzer range card.

(c) *Other weapons, mines, obstacles, OP's, LP's, and other key installations* are located by direction and distance from a known point; e.g., battery center, a howitzer, or a terrain feature.

(3) In all cases, locations should be plotted within 10 meters and directions within 10 mils. On the diagram, the actual location of a weapon is indicated by the base of the stem of the weapon symbol.

7-10. Camouflage

a. *If it can be seen, it can be hit. If it can be hit, it can be killed.* A battery that is concealed or cannot be recognized has greatly increased odds for survival. The following principles of concealment lead to better camouflage:

(1) *Siting.* All terrain has a discernible pattern, either natural or manmade. Select the positions for equipment and personnel that will be camouflaged with an eye toward blending camouflage materials with the natural pattern.

(2) *Camouflage construction.* Use natural and/or manmade material to extend the natural pattern of the area over and around equipment, personnel, and areas of activity. Vegetation can be effectively utilized for this purpose, but remember--

(a) Natural vegetation should be cut from the areas away from the battery position. Freshly cut stumps and limbs encircling the battery area draw attention to the area. Mud can be used to conceal fresh cuts.

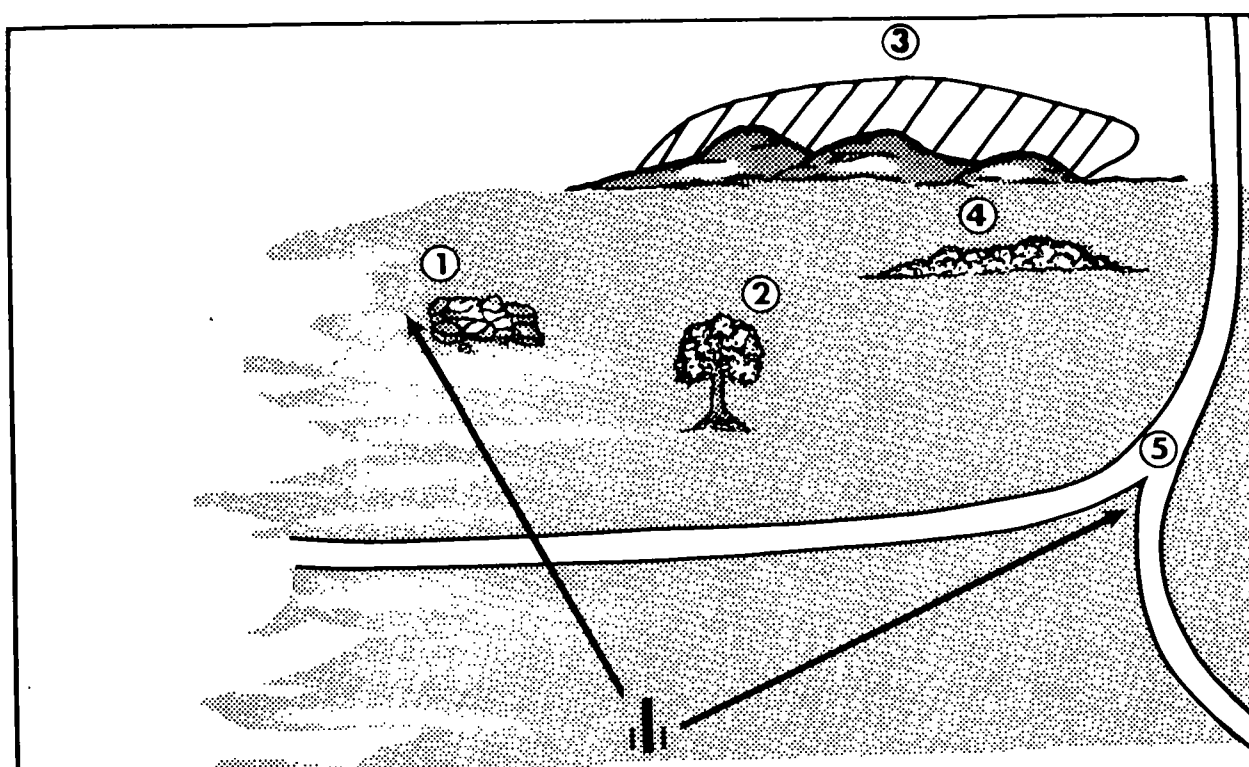
(b) Pine limbs do not grow in oak thickets. Make sure the vegetation *MATCHES* what is naturally in the battery area.

(c) Cut vegetation must be renewed as often as practicable.

(d) Pattern-paint your vehicles and equipment. TC 5-200 will assist you in this area.

(e) Camouflage nets are excellent if sited properly. A howitzer in an open field under a camouflage net is easily seen (though it may not be readily identifiable). That same howitzer between two trees and under a camouflage net will probably not be seen.

(f) Remember the natural pattern and blend with it. In urban areas, try to get equipment into buildings or at least in the shade of buildings. Camouflage nets may not blend with buildings, but storefront awnings will.



GUN # _____ **DATE** _____

NO	SHELL	CHG	FZ	TI	DF	QE	RANGE	DESCRIPTION	RM K
1	HE	7	Q		3800	4	250	ROCK PILE	
2	HE	5GB	Q		3015	6	150	TREE	
3	ICM	1	TI	2.0	2800	1000	500	DEAD SPACE	SWEEP 200m
4	HE	1	TI	2.0	2447	30	400	HEDGE ROW	KJ
5	HE WP	1	TI	2.0	1831	30	400	RD JCT	KJ

Figure 7-5. Howitzer range card.

(3) *Camouflage discipline.* Avoid changing the appearance of the area. Each individual in the battery must be careful not to disclose the presence of military activity. Noise and light discipline are two of the more common problem areas. They both are particularly important at night. Noise draws attention and can be identified. Light leaking from a tent is a target for direct fire weapons.

b. The most common signs of military activity in an otherwise well camouflaged area are tracks, spoil, debris, and movement. The BC must enforce his track plan. Use existing roads and trails. If none are available create some with heavy vehicles to give the appearance that a unit has moved *THROUGH* the area (the roads and trails must have logical starting and terminating points). Spoil from position hardening must be camouflaged. Debris from expended ammunition and the mess area must be policed up and camouflaged. Shine from headlights, windshields, mirrors, and mess equipment can easily be eliminated with scrap canvas, sandbags, and paint, as appropriate. Even the signature of smoke generated by the mess section's stoves can be reduced by utilizing the stoves around dawn and dusk. Camouflage discipline is a concerted, around-the-clock effort to make the camouflage effective. Supervisors should read FM 5-20 for more information.

7-11. Deception

No matter how well the battery is camouflaged, the signature of firing cannot be disguised. The object of deception is to make the enemy direct his counterfire efforts to the wrong area.

a. One technique is to establish dummy positions, but permission must be obtained from higher headquarters first. (Remember to establish dummy positions only in areas where counterfire will not cause friendly casualties.) Techniques used to establish a good dummy position are--

(1) Establish obvious vehicle tracks leading into the dummy position.

(2) Use logs, dead trees, or stove pipe sections to simulate gun tubes.

(3) Place soil around the position as if a fighting position has been prepared.

(4) Make crude attempts to camouflage the position.

(5) Place discarded equipment and trash around the dummy position.

(6) Regularly conduct radio transmissions from or near the dummy position area.

(7) Use the position as an offset registration position or as a roving gun position.

b. Use of the roving gun is another deceptive technique. The roving gun is one weapon of the battery operating away from the battery area. The roving gun moves frequently, since its location will likely be compromised once it has fired a mission. The purpose of employing a roving gun is to minimize the amount of fire from the battery position in order to avoid disclosing the position to the enemy target acquisition means. It may also provide authenticity to the dummy position. Some considerations in employing the roving gun are--

(1) FDC and command and control capability must accompany the roving gun.

(2) The number of missions fired from the same position will be limited.

(3) The roving gun must be positioned so that counterfire does not hit other friendly forces.

(4) An unacceptable reduction in firepower may be caused by pulling one gun out of the normal firing position.

7-12. The Field Exclusion Area

In nuclear capable units the following principles pertaining to the field exclusion area should be applied during field training and included in the defense SOP:

a. Plan to evacuate nuclear weapons in the event the battery area is threatened. If evacuation is impossible or the probability of a successful evacuation is questionable the nuclear weapons must be prepared for destruction.

b. Destruction should be accomplished only after the perimeter has been breached

and it is impossible to repel the attack or when the situation is such that the BC knows it will be impossible to successfully defend his position.

c. The battery commander or senior individual present decides when to destroy the nuclear weapons.

7-13. Defense SOP

A battery is highly vulnerable to enemy action as it first enters a new position. Portions of the battery may still be on the road and the defense plan for the position may not yet have been implemented. Each battery must prepare an SOP that tells each section where its area of responsibility around the battery is until the defense plan is implemented. The SOP and the defense plan must cover the following areas:

a. Each machinegun, air defense weapon, and antitank weapon should be supported by rifle fire.

b. Sectors of fire should be assigned to all crew served weapons and stakes should be set to indicate the lateral limits of the sectors.

c. Periodic reports should be made by personnel at all OP's and LP's.

d. Unmistakable warning signals should be established.

e. At dawn and at dusk small patrols should cover the terrain immediately surrounding the battery; they should give particular attention to the main supply route and avenues of approach to the position area.

f. The resupply plan for small-arms ammunition and grenades should be standardized.

g. Chemical, biological, and nuclear attack detection and alarm procedures and signals should be practiced.

h. At night or under limited visibility, particular attention should be paid to the following:

(1) Use of signs and countersigns.

(2) Noise discipline.

(3) Limited movement within the battery area.

(4) Light discipline.

(5) Employment of available night observation devices.

(6) Use of illumination if required.

(7) Restriction of entrance and exit points on the perimeter.



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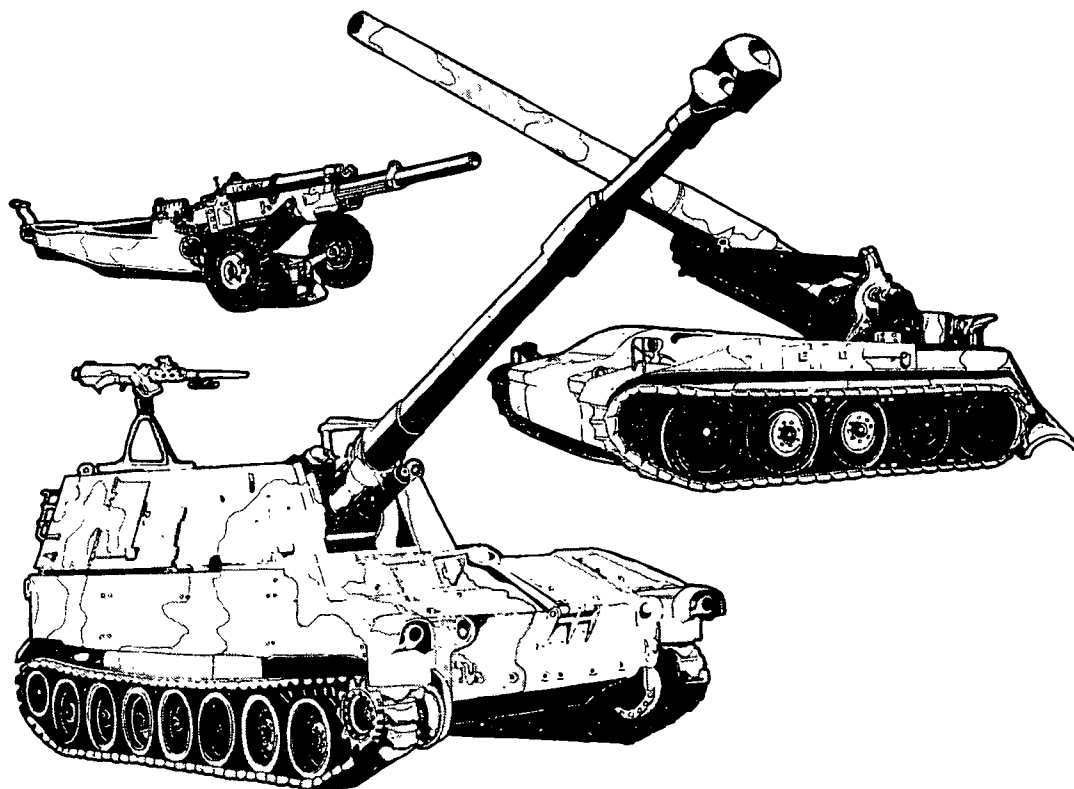


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PART THREE

OPERATIONS



- CHAPTER 8 -- KNOWING AND CARING FOR THE AIMING CIRCLE
- CHAPTER 9 -- LAYING THE BATTERY AND HASTY SURVEY TECHNIQUES
- CHAPTER 10 -- MINIMUM QUADRANT ELEVATION
- CHAPTER 11 -- FIRE COMMANDS AND THEIR EXECUTION
- CHAPTER 12 -- SPECIAL SITUATIONS
- CHAPTER 13 -- COMMUNICATIONS
- CHAPTER 14 -- AMMUNITION CARE AND HANDLING
- CHAPTER 15 -- DUTIES OF SAFETY PERSONNEL DURING SERVICE PRACTICE FIRING

CHAPTER 8

KNOWING AND CARING FOR THE AIMING CIRCLE

Section I. INTRODUCTION

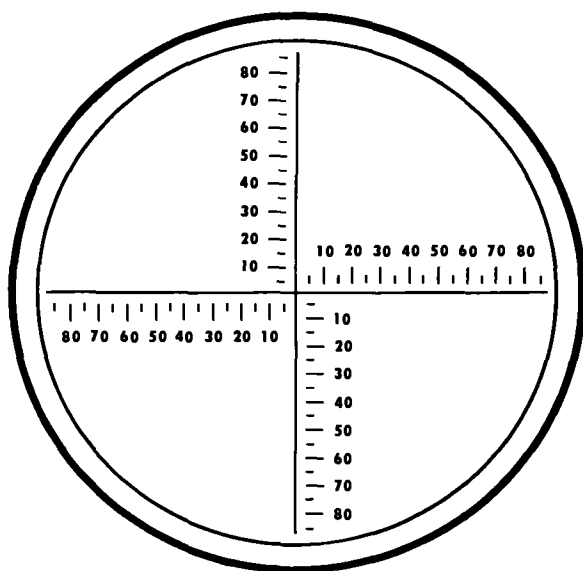
8-1. General

The aiming circle is the cannon battery's primary means of orienting, or laying, on the azimuth of fire. It is a solid, reliable instrument, but it must be cared for and operated correctly. It is important that each person involved with using the aiming circle be thoroughly familiar with how to operate and maintain it. This chapter presents information that should be the starting point for any aiming circle training program.

8-2. Components

The instrument operator must be thoroughly familiar with the components of the aiming circle. The following is a discussion of the major components.

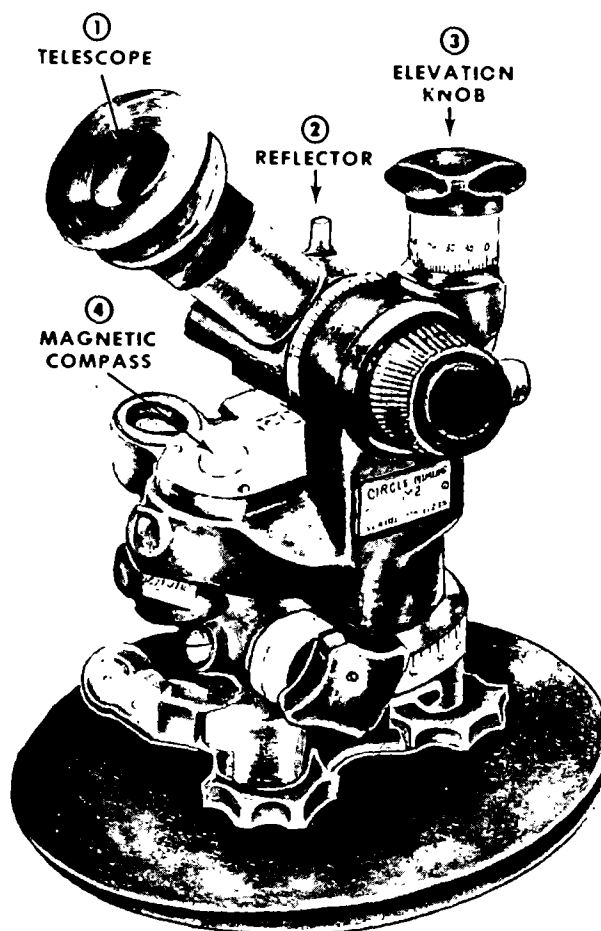
a. ① *Telescope*. The telescope is a 4-power, fixed-focus optical instrument with a reticle pattern like this--



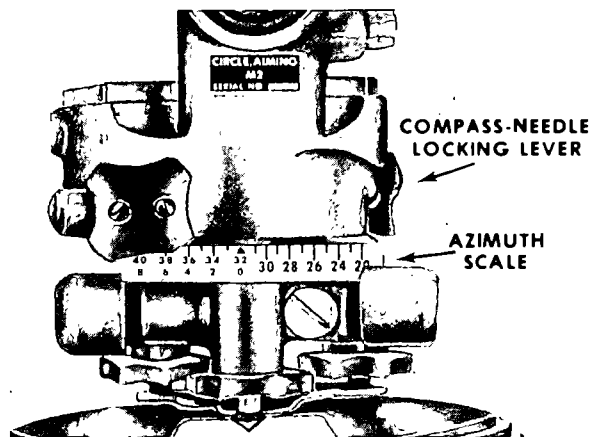
b. ② *Reflector*. The reflector is a plastic signal post mounted on top of the telescope and is used as an aiming point for other instruments sighting on the aiming circle.

c. ③ *Elevation knob*. The elevation knob is used to raise and lower the telescope in order to sight on the sight of a weapon or some other aiming point. The elevation scales are not used during laying and measuring.

d. ④ *Magnetic compass*. The magnetic compass is located in the oblong recess in the top of the body assembly. For rough centering, the magnetic needle may be seen



through the windows on top of the body assembly. A small glass *magnifier*, (5), and reticle with three vertical lines are at one end of the recess to aid in aligning the end of the magnetic needle. When the locking lever is in a vertical position, the needle is locked. When the lever is turned either right or left to the horizontal position, the needle is unlocked. To preclude damage to the magnetic needle, this lever should be returned to the locked position gently.

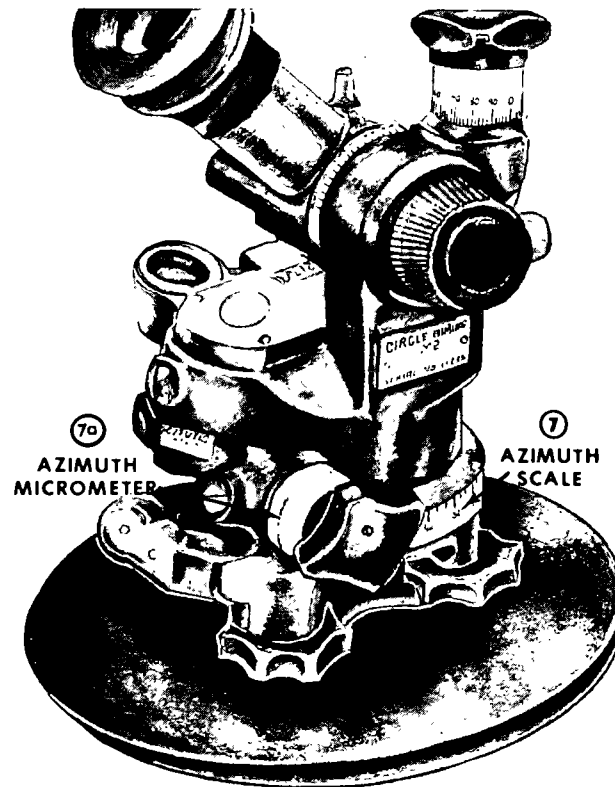
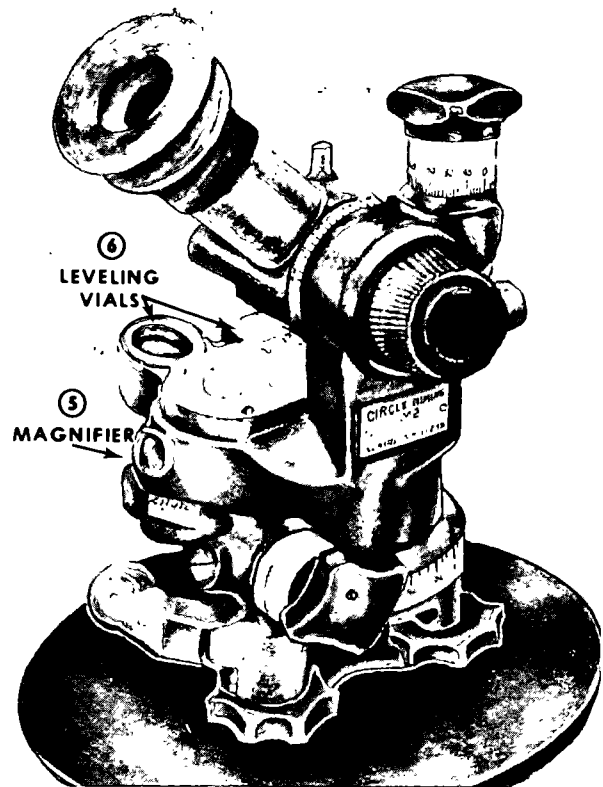


e. (6) *Leveling vials*. There are two tubular leveling vials and one circular leveling vial on the aiming circle. One tubular leveling vial is used in leveling the telescope so that the operator can measure vertical angles. The other tubular leveling vial is used in leveling the aiming circle for measurement of horizontal angles. The circular leveling vial (fisheye bubble) may be used by the firing battery in an emergency.

f. (7) *Azimuth scale and azimuth micrometer*.

(1) The azimuth scale, (7), is located below the magnetic compass housing. It is graduated in 100-mil increments from 0 to 6400 mils and is numbered every 200 mils. The portion of the azimuth scale from 3200 mils through 6400 mils has a second scale (numbered in red from the large black 0 through the black 32 on the azimuth scale).

(2) *The azimuth micrometer*, (7a), is located on the azimuth knob on the lower right side of the magnetic needle housing. It is graduated in 1-mil increments from 0 to 100 mils and is numbered every 10 mils.



g. Upper (recording) motion. The upper motion allows the operator to place instrument readings on the azimuth scale and azimuth micrometer by means of the *azimuth knob*, (8). The values are read on the azimuth scale index, which is located below the magnetic needle magnifier. The upper motion of the instrument has both a fast motion and a slow motion. Lateral movement of the azimuth knob produces fast motion. Rotation of the azimuth knob produces slow motion. Horizontal angles are read in two parts—the hundreds of mils are read from the azimuth scale and the tens and units of mils are read from the azimuth micrometer.

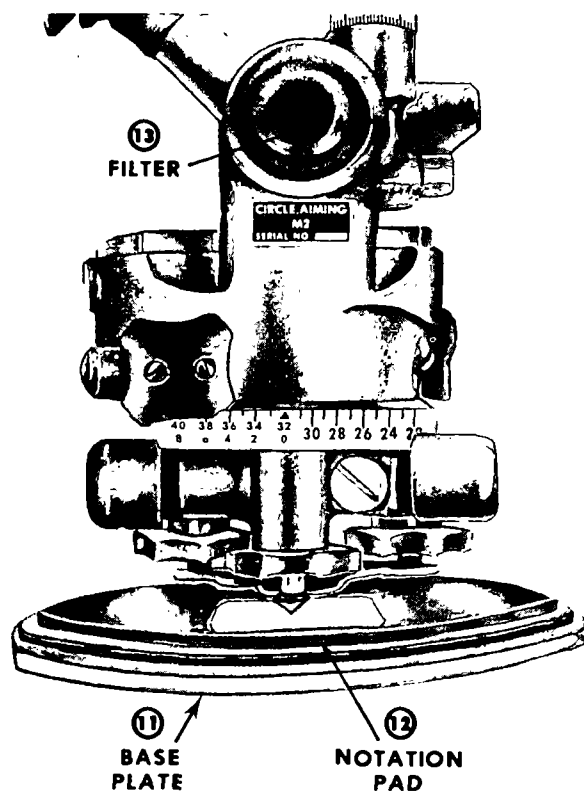
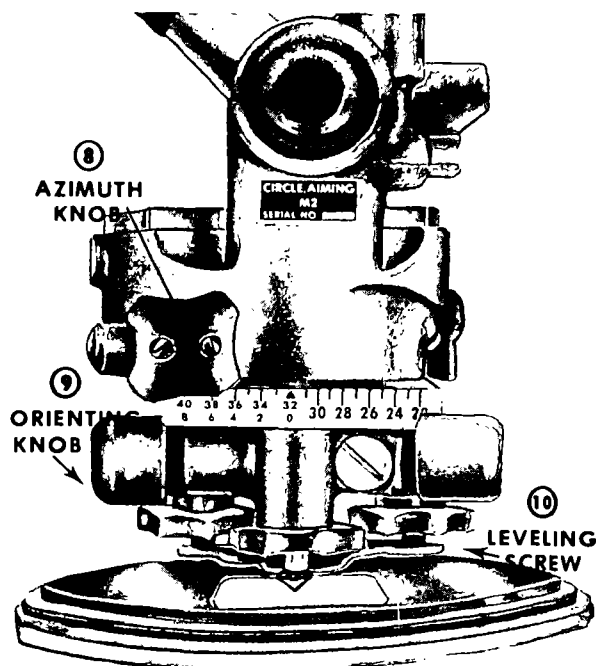
h. Lower (nonrecording) motion. The lower motion is controlled by the *orienting knobs*, (9), and is used to orient the 0-3200 line of the aiming circle without changing the instrument reading. Lateral movement of one orienting knob produces fast movement of the lower motion of the aiming circle. The two orienting knobs should be used simultaneously for slow movement of the lower motion. Caps are provided for covering the orienting knobs to prevent unintentional use of the lower motion.

i. (10) Leveling screws. The three leveling screws are used to level the aiming circle. These screws are on a spring plate located below the orienting knobs and above the base plate assembly.

j. (11) Base plate assembly. The base plate assembly is the base of the instrument when it is mounted on the tripod and also serves as the base of the carrying case. It is a flat circular plate to which the instrument is attached by means of the spring plate.

k. Notation pad. A rectangular *notation pad*, (12), on the base plate is used for recording the declination constant and the vertical angle correction. An instrument-fixing screw is threaded into a socket on the underside of the base plate assembly to attach the instrument to the tripod. The socket is kept clean and free of obstructions by a spring-loaded cover that remains closed when the instrument is not attached to the tripod. The base plate is fitted with a rubber gasket that forms a watertight seal when the cover is latched to the base plate.

l. Filter. A filter (13), which is placed over the eyepiece for protection against the sun's rays, is stored on the cover side of the telescope body, where it is held in place by a spring-loaded ball.



Section II. OPERATING THE AIMING CIRCLE

8-3. Setting Up The Aiming Circle

To set up the aiming circle--

a. Unstrap the legs of the tripod, loosen the leg clamp wing screws, and extend the legs to the desired length. Tighten the leg clamp wing screws.

b. Place the tripod over the point to be occupied. One tripod leg should be pointing in the approximate direction of sighting, and the leg with the night light mount should be to the operator's left. The head of the tripod should be at a height that will place the telescope at a height convenient for the operator.

c. Firmly embed the tripod legs. Make sure the tripod head is approximately level when the legs are embedded, then remove the tripod head cover.

d. Pull back the spring plate on the base of the base plate and place the aiming circle on the tripod.

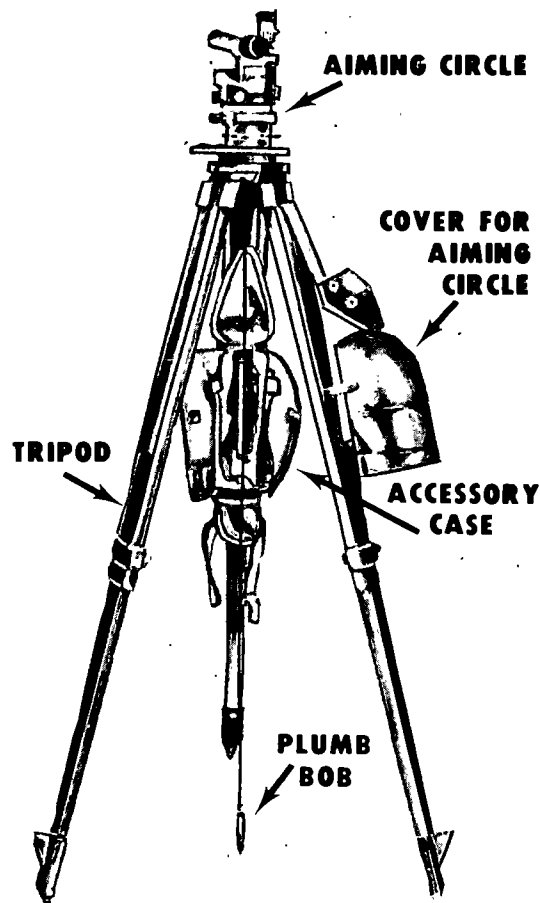
e. Attach the plumb bob to the hook under the tripod head screw and center it over the orienting station by moving the base plate of the aiming circle. The plumb bob should be approximately 1 inch above the station marker.

f. Remove the aiming circle head cover and hang it on the tripod head cover to prevent damage.

g. Screw the instrument fixing screw into the base plate of the aiming circle.

CAUTION: BE CAREFUL NOT TO EXERT EXCESSIVE PRESSURE WHEN TIGHTENING THE INSTRUMENT-FIXING SCREW OR THE SLOTTED ARM WILL BEND AND DAMAGE THE TRIPOD HEAD.

h. Install the night lighting device accessory case if necessary. When you're through the aiming circle should look like this



COMMON MALPRACTICES

- Not clearing the area of magnetic attractions such as weapons, steel helmets, and eyeglasses.

- Failure to set up the tripod so that one leg points in the direction of the sighting. This puts one more tripod leg in the instrument operator's way as he moves around and increases the likelihood that he'll kick a leg and knock the aiming circle off level (or worse).

8-4. Leveling The Aiming Circle

To level the aiming circle for normal use--

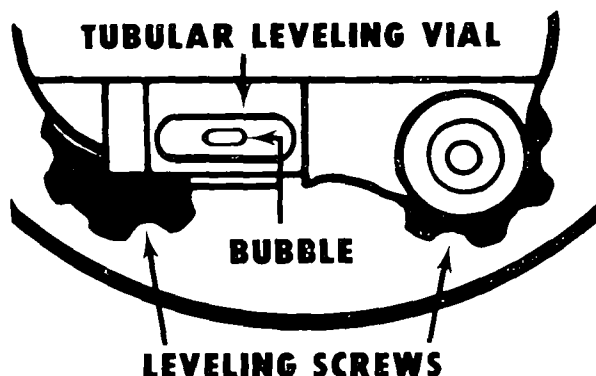
a. Loosen the leveling screws to expose sufficient threads (three-eighths to one-half inch) on the three screws to permit the instru-

ment to be leveled. Rotate the instrument until the axis of the *tubular* leveling vial is parallel to any two of the three leveling screws. Grasp a leveling screw between the thumb and forefinger of each hand. Turn the screws simultaneously so that your thumbs move either toward each other or away from each other at the same time. This movement tightens one screw as it loosens the other. The bubble always moves in the same direction as the left thumb.

b. Rotate the instrument 1600 mils and center the bubble by turning the third leveling screw.

c. Rotate the instrument back to the first position and relevel the bubble if necessary.

d. Repeat these steps until the bubble remains centered in both positions.



e. Rotate the instrument 3200 mils from the first position. If the bubble remains centered in this position, rotate the instrument 3200 mils from the second position. If the bubble remains centered in this position, rotate the instrument throughout 6400 mils. If the bubble remains centered, the instrument is level. If the bubble does not remain centered when the instrument is rotated 3200 mils from the first position, the leveling vial is out of adjustment. To compensate, using the same leveling screws that were used to place the instrument in the first position, move the bubble halfway back to the center of the leveling vial. Rotate the instrument 3200 mils from the second position and, using the other leveling screw, move the bubble halfway back to the center of the level vial. The instrument is now level, and the bubble should

come to rest in its vial at the same off-center position (within one graduation) regardless of the direction in which the instrument is pointed. The instrument should be turned in for repair at the first opportunity.

8-5. Fast Leveling

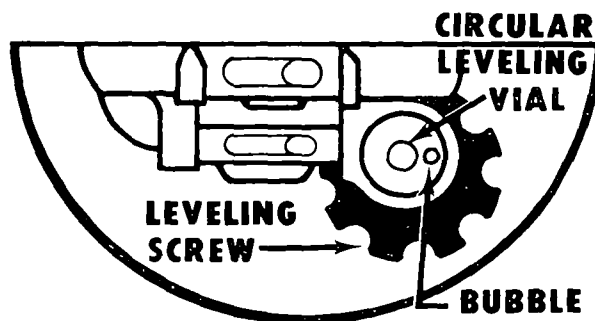
In an emergency situation, when speed is of the essence, the following leveling technique may be used.

a. Loosen the leveling screws approximately halfway.

b. Rotate the head of the aiming circle until the circular leveling vial is over one of the three leveling screws at the bottom of the aiming circle.

c. Using the thumb and forefinger of each hand, turn the other two leveling screws in opposite directions. The bubble will move in the same direction as the left thumb.

d. When the bubble moves on line with the fisheye, center the bubble by using only the third leveling screw. Move the head over each of the other two screws. If more than half the bubble moves out of the center ring, relevel the instrument. If the bubble cannot be centered, use the technique discussed in paragraph 8-4a, and turn the instrument in for repair as soon as possible.



8-6. Taking Down The Aiming Circle

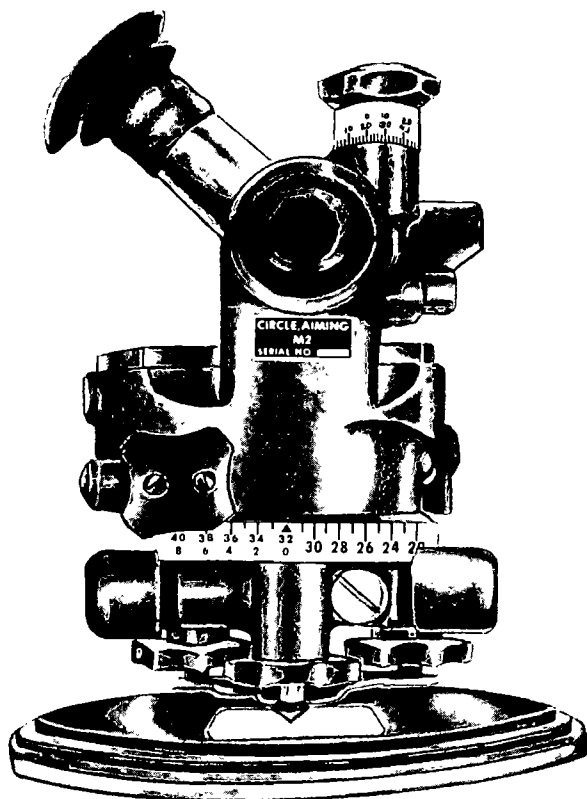
To take down the aiming circle..

a. Tighten the leveling screws to their lower stops, then loosen each screw one-quarter turn.

b. **CHECK TO INSURE THAT THE MAGNETIC NEEDLE IS LOCKED.**

c. Cover the level vials.

d. Place the azimuth knob over the notation pad. The aiming circle should now look like this--



e. Place the carrying case cover over the aiming circle and latch the cover locks.

f. Unscrew the instrument-fixing screw and remove the instrument from the tripod.

g. Replace the tripod head cover.

h. Retract and collapse the tripod legs and tighten the wing screws.

i. Strap the tripod legs together.

8-7. Declinating The Aiming Circle

a. To determine the declination constant for each instrument and to keep this declination constant current, certain rules have been prescribed outlining how often and under what circumstances the aiming circle should be declinated. The aiming circle must be declinated--

(1) After an electrical storm or any time the instrument has received a severe shock, e.g., if it is dropped from the bed of a truck to the ground. The magnetic needle is a delicately balanced mechanism, and any shock may cause a significant change in the declination constant for the instrument.

(2) Any time the aiming circle is moved 25 miles or more from the area in which it was last declinated. Because of local magnetic attractions, any move of the aiming circle may result in an appreciable change in the relationship of grid north and magnetic north as measured by the instrument. If possible, the aiming circle should be redeclinated after each change in the location of the battery position.

(3) A minimum of once every 30 days to determine if any changes in the declination have occurred because of the annual shift of magnetic north or because of accidents involving the instrument that may not have been reported. If a radical change is observed, the instrument should be declinated again within a few days to determine if the observed change is a result of a magnetic storm or is a real change in the characteristics of the instrument.

(4) When it is initially received and any time it is returned from ordnance repair. Variations in the declination constant at different times of the day are not significant enough to warrant declinating at any specific time.

b. There are certain factors that must be considered in determining the location at which an aiming circle is to be declinated.

(1) A declination station should be established at a place that is convenient to the using unit. It may be established by a battalion, by higher headquarters, or by the target acquisition battery.

(2) From the declination station there should be known azimuths to two or more azimuth marks, preferably in opposite directions. (Two azimuth marks are desirable, but one will suffice.) These azimuth marks should be at least 1000 meters from the declination station, but they may be a minimum

distance of 300 meters if necessary.

(3) Declination stations should be established in an area free from magnetic attractions.

c. When a declination station is available, declinate the aiming circle as follows:

(1) Set up and level the aiming circle.

(2) With the upper motion, set the known azimuth to the azimuth mark on the scales of the instrument. Then, with the lower motion, sight on the first azimuth mark.

(3) Release the magnetic needle. With the upper (recording) motion, center the needle.

(4) Read the declination constant directly from the scales (to the nearest 0.5 mil).

(5) Relevel the aiming circle, if necessary, and, using the second azimuth mark if it is available, repeat the above steps. (If a second azimuth mark is not available, use the first azimuth mark again.)

(6) Compare the two declination constants determined. If they agree within 2 mils, determine the mean, express it to the nearest whole mil using standard artillery expression, and record the mean and the date on the notation pad.

IF THE TWO VALUES DIFFER BY MORE THAN 2 MILS, REPEAT THE ENTIRE PROCESS.

d. In a rapidly moving situation, time may not permit the establishment of a declination station by battalion surveyors. Under such circumstances a declination station can be established by simultaneous observation or by observation of Polaris.

e. A third method of declinating, if an accurate position can be determined, is to scale a grid azimuth to two distant points. The following procedures are used:

(1) Place the aiming circle over the selected point and level the instrument.

(2) Select two distant points that can

be identified on a map and scale the direction to them from the occupied point.

(3) Using the direction scaled from the map declinate the aiming circle by the procedures previously discussed.

(4) Compare the two values determined. They must agree within 10 mils.

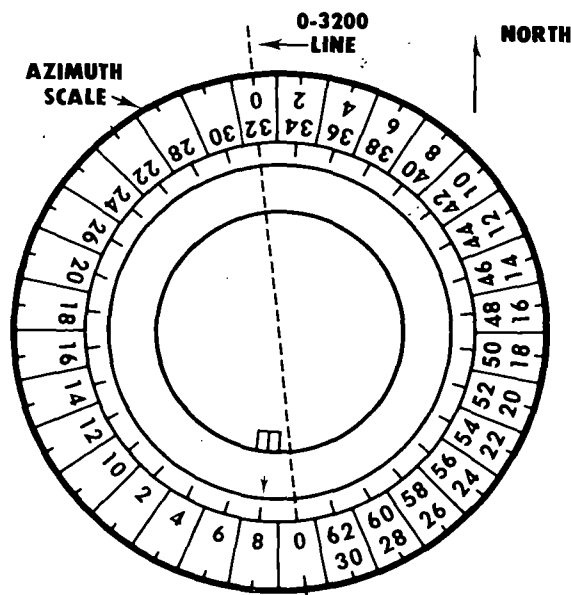
(5) If the values determined agree within 10 mils, determine the mean and record it on the notation pad. If the values do not agree within 10 mils, repeat the entire procedure.

A DECLINATION CONSTANT DETERMINED BY SIMULTANEOUS OBSERVATION OR FROM A MAP SHOULD BE VERIFIED AS SOON AS POSSIBLE.

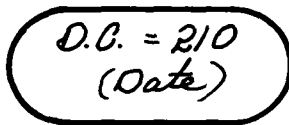
8-8. Measuring Azimuth To A Point

a. The aiming circle can be used to measure an azimuth as follows:

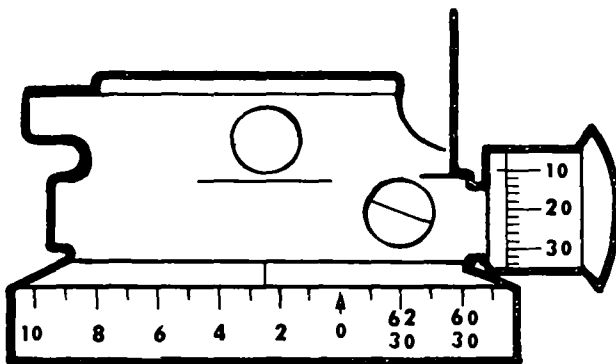
(1) Place the aiming circle so that the 0-3200 line is in an approximate north-south direction and the large 0 of the scale is toward the south.



(2) Check the notation pad to determine the declination constant for your aiming circle;

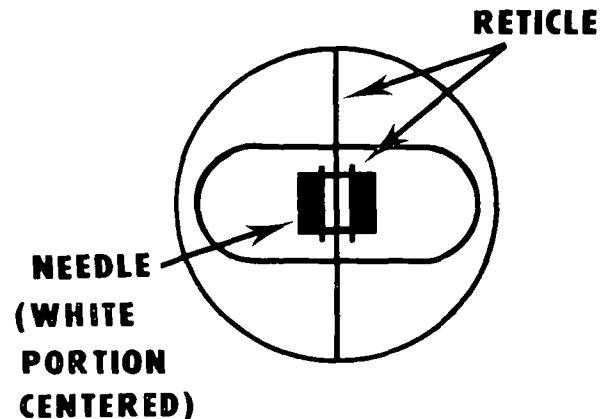


then, with the upper motion, set off the declination constant.



(3) Release the needle and with the lower motion, center the needle to direct the

line of sight to magnetic north and the 0-3200 line of the instrument to grid north. When it is centered, the magnetic needle looks like this--



(4) Lock the needle and, with the upper motion, refer the line of sight to the desired point. Read the grid azimuth from the azimuth scale and the azimuth micrometer.

b. For greater accuracy, repeat this operation two times and take the average of the readings.

Section III. MAINTENANCE

8-9. General

The aiming circle must be handled with tender loving care as it will not stand abuse. The declination constant that is so painstakingly determined may very well be worthless if the aiming circle is dropped or handled in a rough manner.

8-10. Care And Handling Of The Aiming Circle

To get maximum service from the aiming circle:

a. Protect it from shock. Often in a fast-moving situation the executive officer (XO) or the chief of firing battery (CFB) will want to keep the aiming circle head attached to the tripod during movement. This practice is fine and reduces setup time. Extra care must be taken, however, to preclude damage to the instrument when transported in this manner.

b. Periodically compare the declination constants of the two aiming circles of the battery. To make this comparison--

(1) Set the aiming circles up at least 10 meters apart and level them.

(2) Using the method described in paragraph 8-8, have each instrument operator measure the azimuth to the other instrument. If the azimuths do not compare within ± 10 mils, both aiming circles should be redeclinated as soon as possible.

c. Never attempt to force the rotation of any knob past the stops.

d. Keep the instrument clean and dry.

e. Clean the lens with a camel's hair brush and lens tissue *ONLY*.

f. Keep the magnetic needle *locked* any time it is not in use.

g. Place the aiming circle head cover over the aiming circle head for protection whenever it is to be left set up.

h. Be sure all tubular leveling vials are

covered when not in use.

i. Be sure to rotate the azimuth knob until it is over the data plate before attempting to replace the aiming circle head cover.



CHAPTER 9

LAYING THE BATTERY AND HASTY SURVEY TECHNIQUES

Section I. INTRODUCTION

9-1. General

When the battery occupies a firing position, the tubes of the pieces must be pointed, or laid in a known direction. The direction in which the battery is to be laid may be furnished to the battery commander by higher headquarters, or he may estimate the direction on the basis of his knowledge of the situation.

9-2. Responsibilities

a. This chapter discusses all of the meth-

ods for laying the battery and methods the battery can use to provide its own survey data.

b. Firing battery supervisors must know how to establish their own survey control by hasty survey techniques. As a minimum, all officers, the first sergeant, the chief of firing battery, and the gunnery sergeant should be proficient in each of the techniques discussed in section II.

Section II. HASTY SURVEY TECHNIQUES

9-3. General

a. When the time and the tactical situation permit, accurate survey data will be provided by a survey section. Ideally, the battery will pull into position and will find the battery center, the orientation station (OS), and the end of the orienting line (EOL) marked. A tag on the battery center stake will give the coordinates of the position, and a tag on the OS stake will give the azimuth to the end of the orienting line (EOL). When units are moving frequently, the survey section will be hard pressed to meet all of the survey demands. In this situation, the battalion survey section can be employed in 2-to 3-man teams attached to each firing battery. These teams perform the hasty survey operations discussed in this section and can train key personnel to perform the operations.

b. Because this team may not be available, battery supervisors must be prepared to use the hasty survey techniques prescribed in this section to *provide their own survey control*. Though not as precise as the techniques used by survey personnel, these methods will serve to place the firing batteries of the battalion on a *COMMON GRID*. The direction determined by these methods will be more

accurate than that determined by use of the magnetic needle in the aiming circle.

c. The key is *TRAINING*. The XO, chief of firing battery, gunnery sergeant and other battery supervisors must be trained in these survey techniques. Hasty survey techniques must be integrated into field exercises.

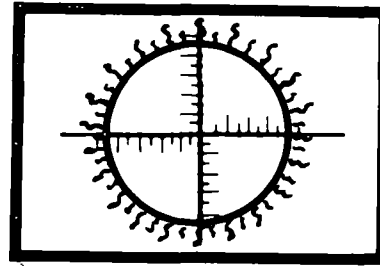
d. The hasty survey techniques discussed in this section fall into two categories: *DIRECTIONAL CONTROL* and *DETERMINING BATTERY (PLATOON) LOCATION*. Hasty survey techniques will be used to provide the most accurate direction and battery (platoon) location possible when survey is not available. The establishment of *DIRECTION* has priority.

9-4. Directional Control

a. The fastest and easiest method of establishing the orienting line by hasty survey is *SIMULTANEOUS OBSERVATION*. Clear weather and good communications with the master station must exist. Survey personnel man the master station, and cannon battery personnel will man the flank station (fig 9-1). Communication may be by wire or radio. Normal communication procedures

are used. Operators at both stations begin tracking the same celestial body with their respective instruments. As the master station operator tracks, he announces, *TRACKING, TRACKING, TRACKING, TIP*. The sighting is made by the flank station operator when *TIP* is announced. At night, any predetermined celestial body may be tracked in the observation.

THE PROPER METHOD OF SIGHTING ON THE SUN IS LIKE THIS--



MASTER STATION

1. Set the known azimuth value on the instrument scale and sight on the azimuth mark.
2. Track the celestial object and announce *TIP*; read the azimuth to the object directly from the scale and announce it to the flank station.
3. When the flank station is ready, track the object and announce *TIP* again and record the second azimuth.
4. Obtain the angle from the flank station and add it to the first azimuth. Results must agree with the second azimuth within ± 2.0 mils.

Note. If the line of sight established by the flank station in step 3 does not place the EOL in a satisfactory location, it may be moved after completion of the azimuth verification by placing the azimuth reported by the master station in step 2 on the scales and turning the aiming circle line of sight to a more satisfactory location. Reemplace the EOL marker and read the *new* azimuth on the scales.

FLANK STATION

1. Set 0.0 mils on the aiming circle horizontal scales.
2. Identify the predetermined celestial object; with the *lower* motion, sight on and track the object until the master station announces *TIP*.
3. Depress the telescope of the aiming circle and place the EOL squarely along the aiming circle line of sight. Record the azimuth that is announced by the master station.
4. With the *upper* motion, track the celestial object until the master station announces *TIP*.
5. Read the angle that was measured and report it to the master station (read the horizontal scales).
6. Wait for verification from the master station to insure that the observation was within tolerance.
7. The azimuth recorded in step 3 is the azimuth to the EOL and is used in computing the orienting angle.

DO NOT OBSERVE THE SUN WITHOUT A FILTER ON THE TELESCOPE LENS.

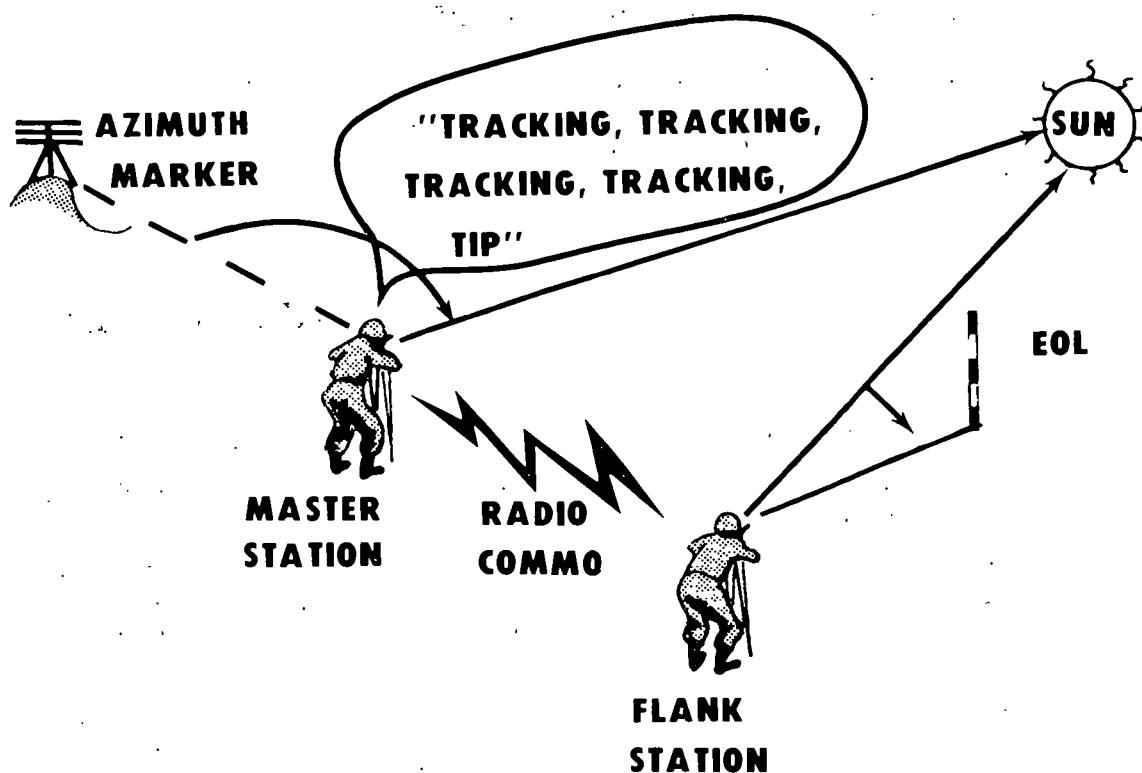


Figure 9-1. Simultaneous observation.

An example of the radio transmissions required for this procedure is as follows--

- | FLANK STATION | MASTER STATION |
|---|---|
| ① _____ this is _____, ready to observe, over. | ② This is _____, start tracking, out. |
| | ③ This is _____, tracking, tracking, tracking, TIP, out. |
| | ④ This is _____, azimuth _____, over. |
| ⑤ This is _____, azimuth _____, ready to observe, over. | ⑥ This is _____, tracking, tracking, tracking, TIP, over. |
| ⑦ This is _____, angle _____, over. | ⑧ This is _____, azimuth verified, out. |

b. *Observation of Polaris* is a second technique of establishing very accurate directional control. It is simple and fast and has the distinct advantage of requiring no radio or wire communications. Caution must be exercised, however, since the instrument operator must be thoroughly trained in finding both Polaris and the star Kochab, which are in the constellation known as the Little Dipper (Ursa Minor).

(1) Polaris is one of the two brightest stars in the constellation Ursa Minor. Because it moves in a small elliptical orbit about the celestial North Pole, it is commonly referred to as the North Star. Refer to figure 9-2 and you can see that Polaris is the last star in the handle of the Little Dipper. You will also notice that two stars in the bowl of the Big Dipper (Ursa Major) actually point toward Polaris. These stars are called The Pointers.

Polaris is approximately five times the distance between The Pointers along an imaginary line from the Big Dipper. On the opposite side of the Little Dipper you will see the constellation Cassiopeia, which looks like a lazy W.

(2) The second star needed to perform the observation is Kochab. Kochab is the other bright star (as bright as Polaris) in the Little Dipper. It is the front star of the bowl and is the ONLY bright star between Polaris and the Big Dipper. *For rough orientation of the aiming circle*, first set the declination constant on the scale and center the magnetic needle. Next, from a map determine your latitude to the nearest degree and convert it to mils by multiplying by 18. Set this value on the elevation scales of the aiming circle. Polaris will appear in or very close to your line of sight.

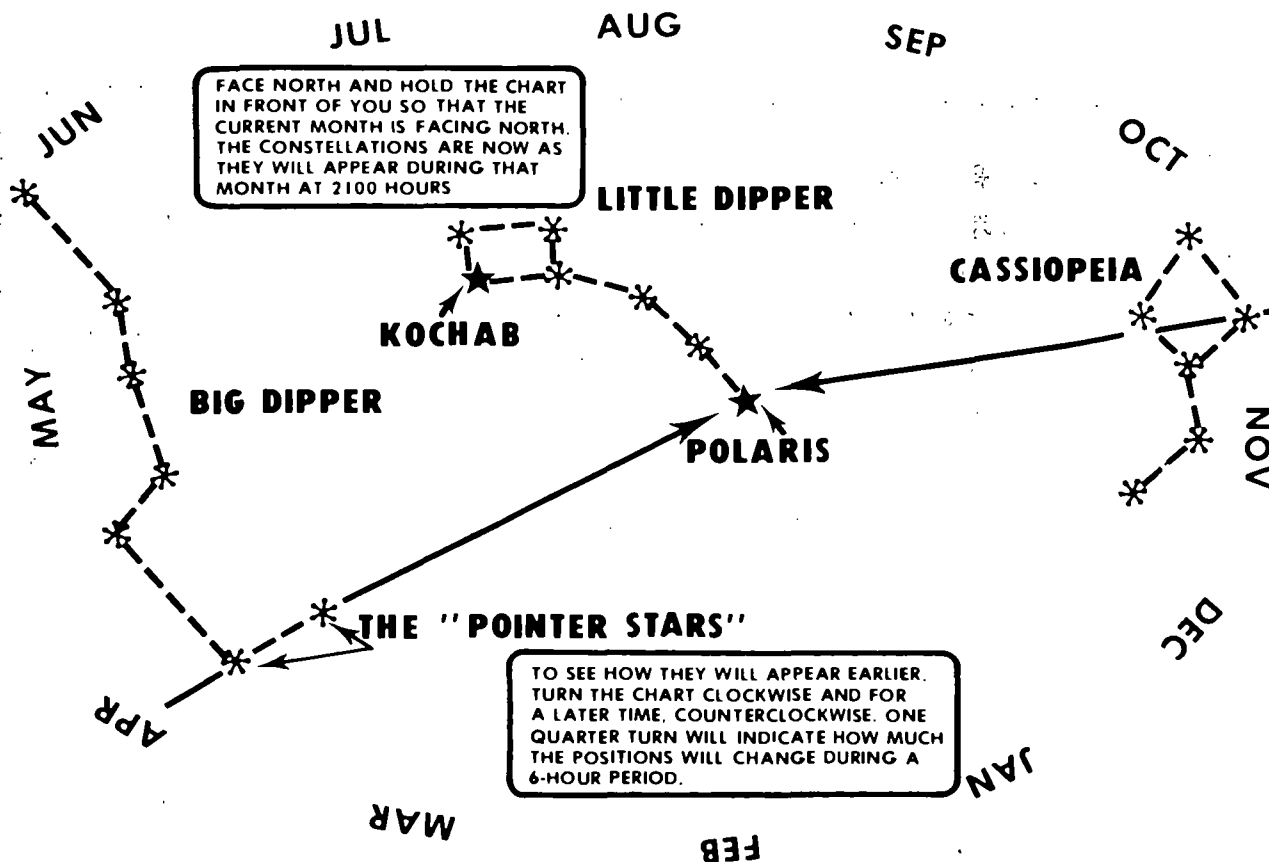


Figure 9-2. Locating Polaris.

(3) To determine an azimuth using this technique a horizontal, *CLOCKWISE* angle must be measured *FROM* Kochab *TO* Polaris. *THE ANGLE MUST BE MEASURED IN THIS MANNER.* The steps for establishing direction by observing Polaris are--

(a) Set up and level the aiming circle. Set 0.0 on the azimuth scale.

(b) Locate Kochab and place the vertical crosshair of the instrument on Kochab with the LOWER motion.

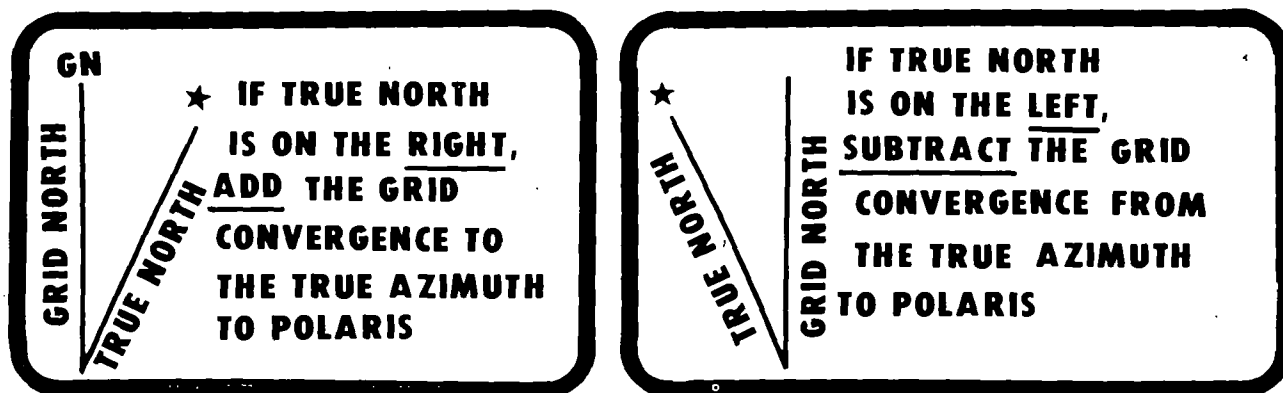
(c) Using the UPPER motion, turn the azimuth micrometer knob and center the vertical crosshair on Polaris.

(d) Read and record the value on the azimuth and azimuth micrometer scales. Then depress the telescope and place an aim-

ing post along the resultant line of sight. The aiming circle then becomes the OS and the stake becomes the EOL.

(e) Enter table 9-1, 9-2, 9-3, or 9-4 (whichever is closest to your latitude) on the LEFT with the measured angle from Kochab to Polaris. Read RIGHT to the appropriate graph; then read DOWN to determine the TRUE azimuth to Polaris.

(f) To compute the grid azimuth, determine the grid convergence from the bottom of the map sheet and apply it to the true azimuth as shown in figure 9-3. If it is desirable to move the location of the EOL, set the *grid* azimuth on the aiming circle with the upper motion. Then, with the lower motion, turn the line of sight to the desired location and direct an assistant to reposition the aiming post. Record the new azimuth to the EOL.



REMEMBER- -RIGHT-ADD, LEFT-SUBTRACT

Figure 9-3. Application of grid convergence.

Table 9-1. Determining True Azimuth, 20° North Latitude.

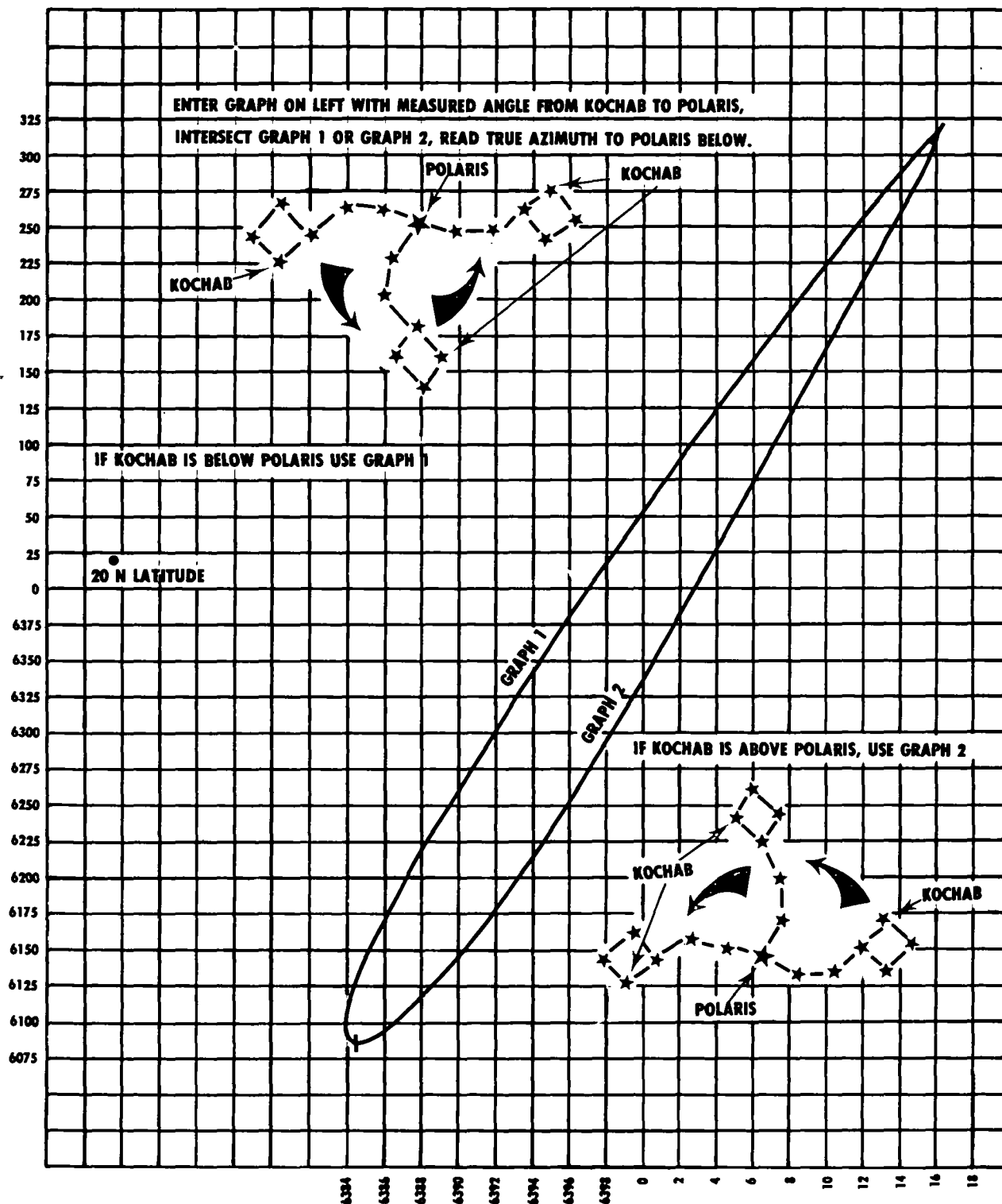


Table 9-2. Determining True Azimuth, 35° North Latitude.

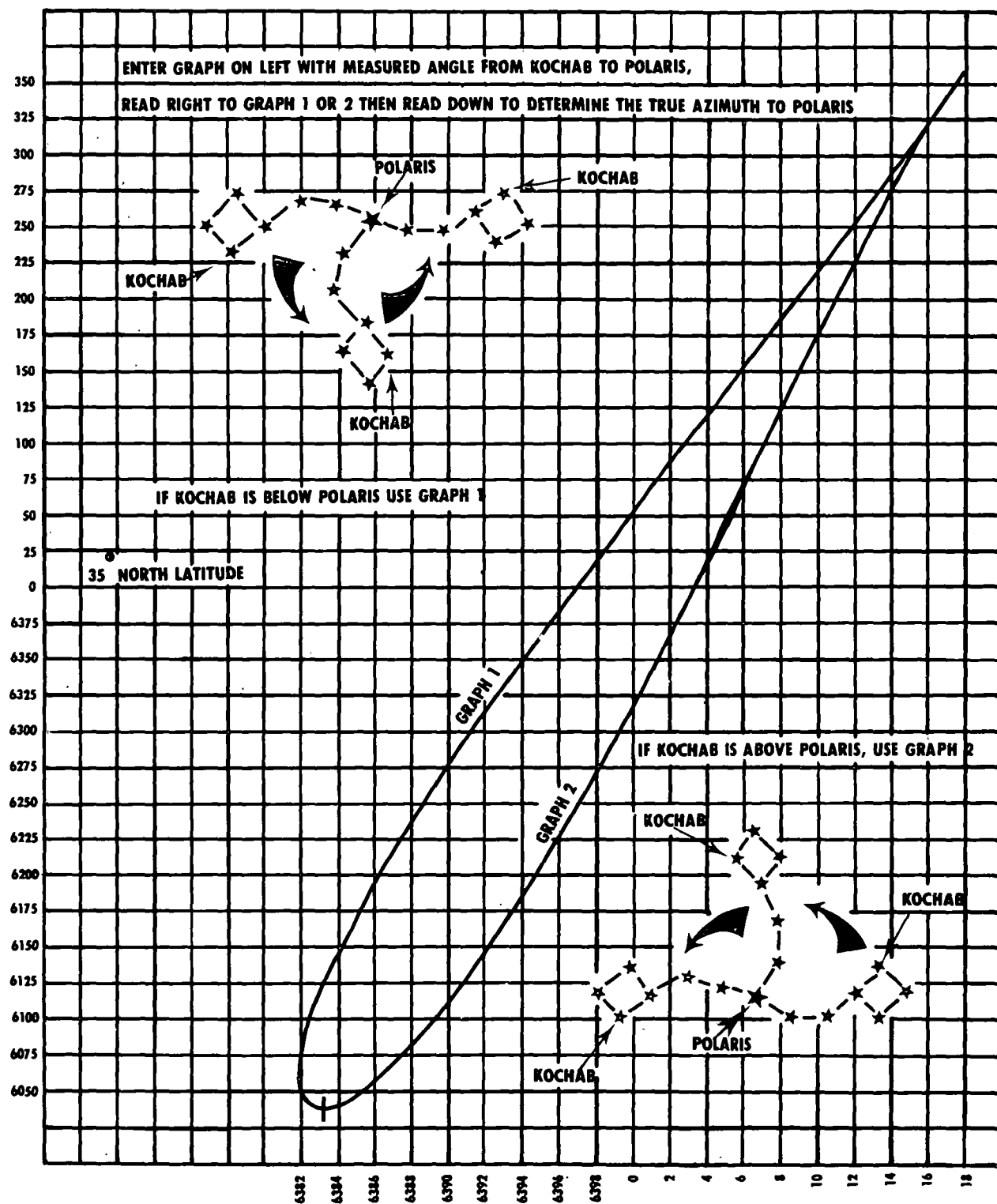


Table 9-3. Determining True Azimuth, 42° North Latitude.

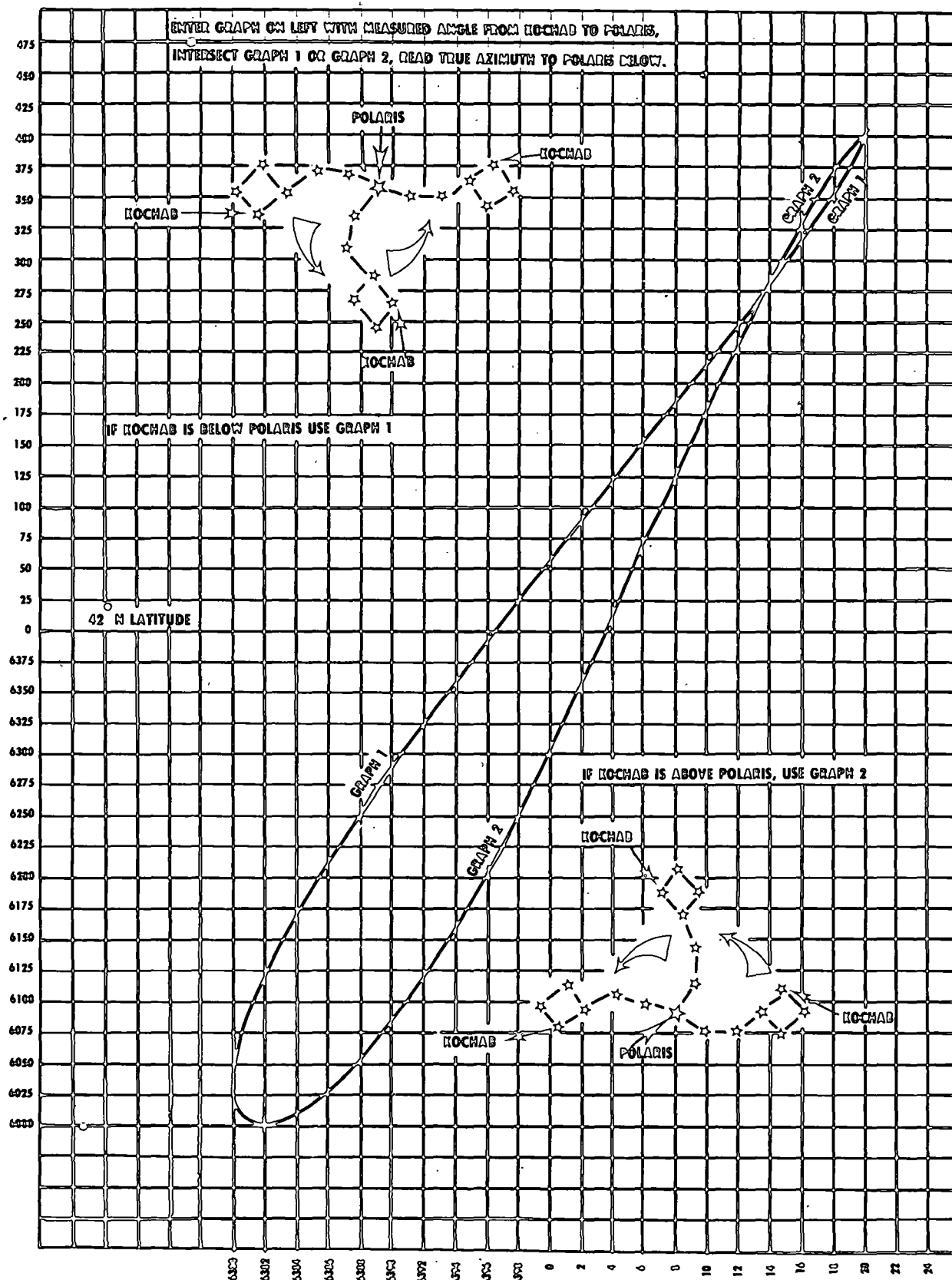
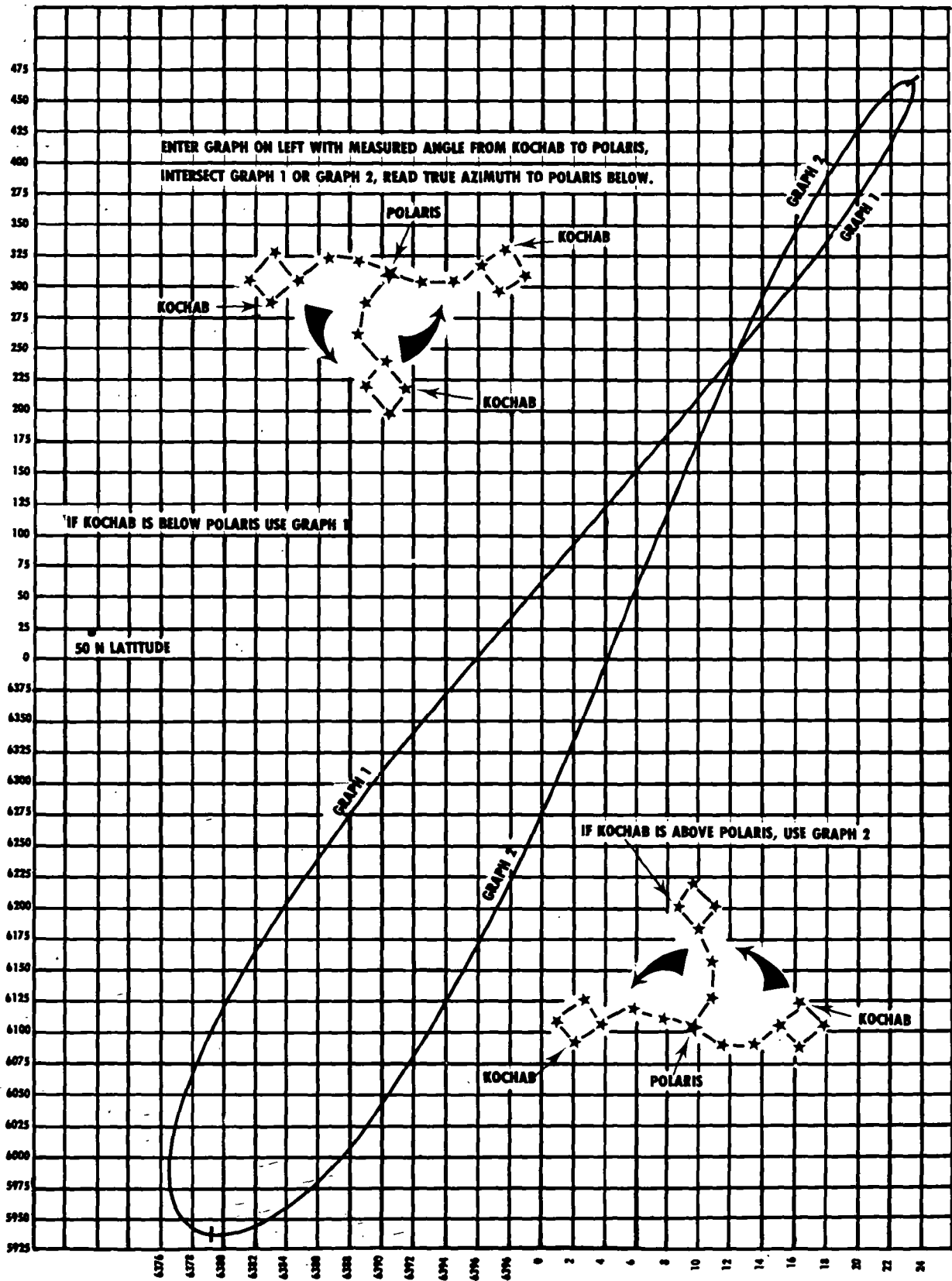


Table 9-4. Determining True Azimuth, 50° North Latitude.



c. *Directional traverse* is a third method of determining an accurate direction. If bad weather or poor communications prohibit a simultaneous observation, directional traverse can be used to establish the orienting line. While more time consuming and not as accurate as simultaneous observation or the observation of Polaris, this method still provides more accurate results than scaling an azimuth from a map or floating the needle within the compass of the aiming circle. Only one item of known data is required to start: an accurate known azimuth mark. Normally, the survey section chief will be able to identify a start point and a known azimuth mark reasonably close to the battery position. By turning horizontal angles with the aiming circle, the operator can extend azimuth control into the battery area and establish the orienting line. All angles are measured clockwise from the point to which an azimuth is known (called the rear station). For example, in figure 9-4, an orienting station is required at point B. The azimuth from point A to an azimuth mark is known.

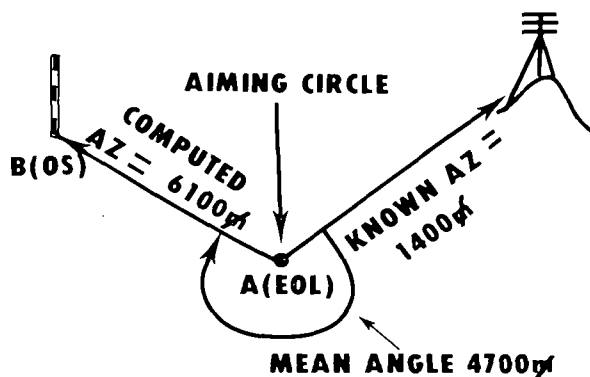


Figure 9-4. Directional traverse.

The steps for determining the azimuth from A to B are--

- (1) Set up and level the aiming circle over point A.
- (2) With the upper motion, set 0.0 mils on the aiming circle.
- (3) With the lower motion, sight on the azimuth marker (rear station).
- (4) Using the upper motion, sight on point B. The value on the scales (read to the nearest 0.5 mil) is reading number 1.

(5) Using the lower motion, sight back on the azimuth marker.

(6) Using the upper motion, sight on point B. The value on the scales (read to the nearest 0.5 mil) is reading number 2.

(7) Divide reading number 2 by 2. If the result is within ± 0.5 mil of reading number 1, it is the mean horizontal angle to be used in computations. If it is not, remeasure the angle.

(8) Add the mean horizontal angle to the known azimuth to the azimuth marker--

$$\begin{array}{r} 1400 \\ +4700 \\ \hline 6100 \end{array}$$

If this value is greater than 6400, subtract 6400. The result is the azimuth from station A to station B.

(9) Since the azimuth from the OS to the EOL is required to compute the orienting angle, determine the back-azimuth by adding or subtracting 3200--

$$\begin{array}{r} 6100 \\ -3200 \\ \hline 2900 = \text{Azimuth to EOL} \end{array}$$

If terrain, vegetation, fog, or other factors prohibit sighting from the start point to the orienting station, intermediate stations are required and additional traverse legs are created. The procedure for determining the azimuth to each forward station is the same as that previously discussed and shown in figure 9-4.

9-5. Determining Battery (Platoon) Locations

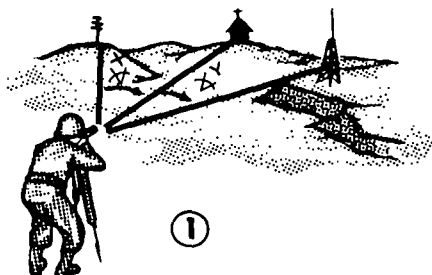
The battery may be required to locate its own roving gun, alternate, supplementary, offset registration, or primary positions as accurately as possible. Very often the locations of these positions can be determined by a simple map spot. Whenever possible, however, one of the following more accurate methods should be used.

a. *Graphic resection.*

- (1) A map, an aiming circle, and paper are required. The steps in determining loca-

tion by the graphic resection method are as follows:

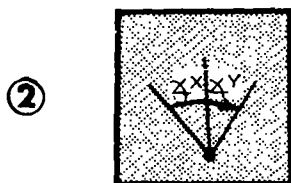
- ① Identify three distant points that also appear on a map.



With an aiming circle, measure the angles between these points. Preferably, the angles between the points should be greater than 400 mils.

- ② On tracing paper place a dot representing the aiming circle location. Draw a line from this dot in any direction. With a protractor, draw two additional lines from the dot to represent the angles measured in step ①.

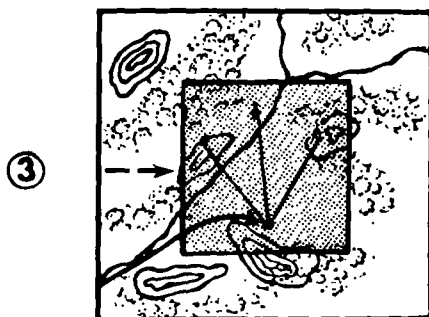
TRACING PAPER



AIMING CIRCLE LOCATION

- ③ Place the tracing paper over a map of the area and position it so that the three lines pass through their respective distant points. The dot represents the location of the aiming circle on the map.

MAP



(2) If the angles are plotted with a standard protractor (accurate to approximately 10 mils) and oriented over a 1:50,000-scale map, the resection should be accurate to within 100 meters. For greater accuracy, the range-deflection protractor (RDP) and a 1:25,000-scale map may be used. Should a 1:25,000-scale map not be available, the coordinates of the distant points can be scaled from a map and plotted on a 1:25,000 grid sheet.

(3) Graphic resection can be used to establish the coordinates of a point or to check the accuracy of a map spot. If the resection cannot be performed from battery center, the battery center coordinates can be estimated on the basis of the coordinates of the nearby resected point.

b. Graphic traverse. Another method of obtaining coordinates is graphic traverse. Although more time consuming than graphic resection, graphic traverse yields considerably greater accuracy.

(1) Graphic traverse combines the measurement of angles in directional traverse with the measurement of distances so that the azimuth and distance of each leg are known. A graphic traverse must be started at a point that has known coordinates and a known azimuth. As mentioned in the discussion of directional traverse, the battalion surveyors will normally be able to identify such a point and provide the starting data. If these data are not provided, a well-defined feature, such as a road junction, can be used as a start point, its coordinates can be scaled from the map, and a direction can be established by simultaneous observation.

(2) Angles are measured and azimuths of traverse legs are computed in the same manner as in directional traverse. In addition, the distance of each traverse leg is measured. The FADAC may be used to convert these data to coordinates or they may be plotted on a grid sheet. Each traverse leg appears as a polar plot, with a known starting point, a known azimuth, and a known distance. To insure a high degree of accuracy, the azimuth of each leg should be plotted with a range-deflection protractor, and its distance should be measured with a plotting

scale. Graphic traverse normally establishes both the orienting line and the coordinates of battery center. The forward point of the last leg is normally battery center, while the previous leg serves as the orienting line (see fig 9-5).

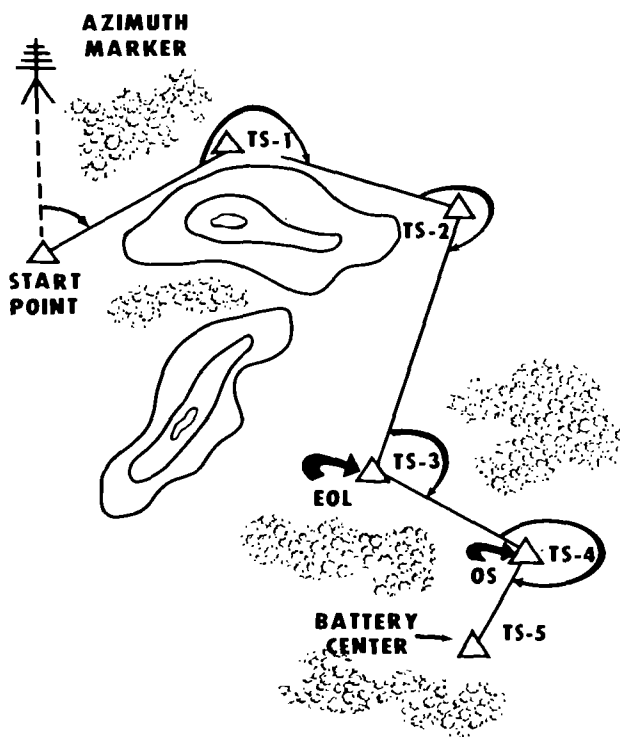


Figure 9-5. Graphic traverse.

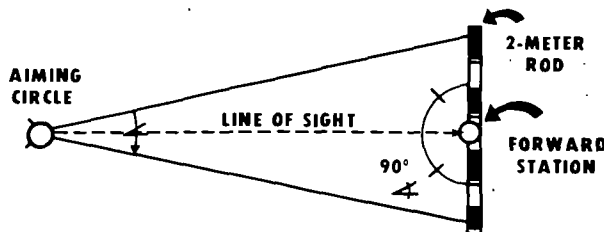
(3) The distance of each traverse leg can be measured in a variety of ways. The easiest methods, listed below, include *pacing*, use of *communication wire*, and *subtense*.

(a) *Pacing* is certainly the easiest method of determining distance, but it does require a soldier whose pace is *accurate*. Also, because the distance is plotted on a chart, the soldier's pace must reflect the horizontal, not slope, distance of each traverse leg.

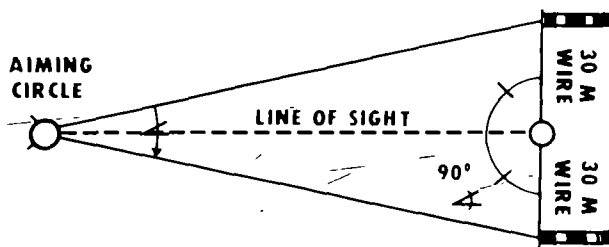
(b) *Communication wire* (WD-1/TT) cut into a known length (e.g., 30 meters) may also be used in the same manner as the surveyor's steel 30-meter tape provided it is held in a horizontal plane. The use of communications wire is a more accurate method than pacing. The wire should be measured with a surveyor's 30-meter tape. The soldiers should count the number of whole lengths of com-

munications wire to the forward station. The remaining partial length can be determined if the wire is marked with tape at each 1-meter increment. Details for accurate taping procedures are in FM 6-2.

(c) In the *subtense* method the aiming circle is used to measure the angle that subtends a base of known length; i.e., the subtense bar. The ideal subtense bar is a 2-meter bar. This bar can be locally fabricated from an aiming post. This bar is placed over the point to which the distance is being measured. It must be placed or held in a horizontal plane, perpendicular to the aiming circle line of sight. The aiming circle is used to measure the horizontal angle from the left edge to the right edge of the 2-meter bar. This angle is measured twice and the



mean horizontal angle is used as an entry argument for determining the distance, in table 9-5. The 2-meter bar will accurately determine distances up to 250 meters. If longer distances are to be measured, a 60-meter base can be employed, which will be accurate out to distances of 1000 meters. A 30-meter length of communications wire can be used to establish the base, as illustrated below.



Again, the base must be perpendicular to the line of sight of the aiming circle, and its left and right ends must be marked by aiming stakes. Enter table 9-6 with the mean horizontal angle to extract the distance.

Table 9-5. Subtense.

To be used with 2-meter subtense rod. Angles in mils, distances in meters.

Angle	DIST	Angle	DIST	Angle	DIST	Angle	DIST	Angle	DIST	Angle	DIST
7.0	291.03	14.0	145.51	21.0	97.01	28.0	72.75	35.0	58.20	42.0	48.50
.2	280.99	.2	142.96	.2	95.86	.2	72.11	.2	57.97	.2	48.21
.5	271.62	.5	140.49	.5	94.75	.5	71.48	.5	57.38	.5	47.93
.8	262.86	.8	137.65	.8	93.66	.8	70.85	.8	56.98	.8	47.65
8.0	254.65	15.0	135.81	22.0	92.60	29.0	70.24	36.0	56.58	43.0	47.37
.2	246.93	.2	133.58	.2	91.56	.2	69.64	.2	56.19	.2	47.10
.5	239.67	.5	131.42	.5	90.54	.5	69.05	.5	55.81	.5	46.82
.8	231.50	.8	129.34	.8	89.54	.8	68.47	.8	55.43	.8	46.56
9.0	226.35	16.0	127.32	23.0	88.57	30.0	67.90	37.0	55.05	44.0	46.29
.2	220.23	.2	125.36	.2	87.62	.2	67.34	.2	54.68	.2	46.08
.5	214.44	.5	123.46	.5	86.68	.5	66.79	.5	54.32	.5	45.77
.8	208.94	.8	121.62	.8	85.77	.8	66.24	.8	53.96	.8	45.47
10.0	203.72	17.0	119.83	24.0	84.88	31.0	65.71	38.0	53.60	45.0	45.26
.2	198.75	.2	118.09	.2	84.00	.2	65.18	.2	53.25		
.5	194.02	.5	116.41	.5	83.15	.5	64.67	.5	52.91		
.8	188.63	.8	114.77	.8	82.31	.8	64.16	.8	52.57		
11.0	185.20	18.0	113.17	25.0	81.48	32.0	63.66	39.0	52.23		
.2	181.08	.2	111.62	.2	80.68	.2	63.16	.2	51.90		
.5	177.14	.5	110.11	.5	79.89	.5	62.68	.5	51.57		
.8	173.38	.8	108.65	.8	79.11	.8	62.20	.8	51.24		
12.0	169.76	19.0	107.22	26.0	78.35	33.0	61.73	40.0	50.92		
.2	166.30	.2	105.82	.2	77.60	.2	61.26	.2	50.67		
.5	162.97	.5	104.47	.5	76.87	.5	60.81	.5	50.29		
.8	159.78	.8	103.15	.8	76.15	.8	60.36	.8	49.99		
13.0	156.70	20.0	101.86	27.0	75.45	34.0	59.91	41.0	49.68		
.2	153.75	.2	100.60	.2	74.75	.2	59.47	.2	49.38		
.5	150.90	.5	99.37	.5	74.07	.5	59.04	.5	49.08		
.8	148.16	.8	98.17	.8	73.41	.8	58.62	.8	48.79		

Table 9-6. Subtense.

To be used with 60-meter subtense base. Angles in mils, distances in meters.

∠	DIST	∠	DIST	∠	DIST	∠	DIST	∠	DIST	∠	DIST
61.0	1001.59	77.0	793.33	93.0	656.70	109.0	560.16	125.0	488.31	141.0	432.75
.2	997.50	.2	790.76	.2	654.94	.2	558.87	.2	487.33	.2	431.98
.5	993.45	.5	788.21	.5	653.18	.5	557.59	.5	486.36	.5	431.22
.8	989.42	.8	785.67	.8	651.44	.8	556.32	.8	485.39	.8	430.45
62.0	985.43	78.0	783.15	94.0	649.70	110.0	555.06	126.0	484.42	142.0	429.69
.2	981.47	.2	780.64	.2	647.98	.2	553.79	.2	483.46	.2	428.94
.5	977.54	.5	778.16	.5	646.26	.5	552.54	.5	482.51	.5	428.18
.8	973.64	.8	775.68	.8	644.55	.8	551.29	.8	481.55	.8	427.43
63.0	969.78	79.0	773.23	95.0	642.85	111.0	550.05	127.0	480.60	143.0	426.68
.2	965.94	.2	770.78	.2	641.16	.2	548.81	.2	479.65	.2	425.93
.5	962.14	.5	768.36	.5	639.48	.5	547.57	.5	478.71	.5	425.19
.8	958.36	.8	765.95	.8	637.81	.8	546.35	.8	477.77	.8	424.45
64.0	954.62	80.0	763.55	96.0	636.15	112.0	545.12	128.0	476.84	144.0	423.71
.2	950.90	.2	761.17	.2	634.49	.2	543.91	.2	475.90	.2	422.97
.5	947.21	.5	758.80	.5	632.85	.5	542.70	.5	474.98	.5	422.24
.8	943.55	.8	756.45	.8	631.21	.8	541.49	.8	474.05	.8	421.50
65.0	939.92	81.0	754.11	97.0	629.58	113.0	540.29	129.0	473.13	145.0	420.77
.2	936.32	.2	751.79	.2	627.96	.2	539.10	.2	472.21	.2	420.05
.5	932.74	.5	749.48	.5	626.35	.5	537.91	.5	471.30	.5	419.32
.8	929.19	.8	747.19	.8	624.74	.8	536.48	.8	470.39	.8	418.60
66.0	925.67	82.0	744.91	98.0	623.15	114.0	535.54	130.0	469.48	146.0	417.88
.2	922.17	.2	742.64	.2	621.56	.2	534.37	.2	468.58	.2	417.17
.5	918.70	.5	740.39	.5	619.98	.5	533.20	.5	467.68	.5	416.45
.8	915.26	.8	738.15	.8	618.41	.8	532.03	.8	466.78	.8	415.74
67.0	911.84	83.0	735.92	99.0	616.84	115.0	530.87	131.0	465.89	147.0	415.03
.2	908.45	.2	733.71	.2	615.29	.2	529.72	.2	465.00	.2	414.32
.5	905.08	.5	731.51	.5	613.74	.5	528.57	.5	464.11	.5	413.62
.8	901.74	.8	729.33	.8	612.20	.8	527.43	.8	463.23	.8	412.92
68.0	898.42	84.0	727.15	100.0	610.66	116.0	526.29	132.0	462.35	148.0	412.22
.2	895.13	.2	724.99	.2	609.14	.2	525.15	.2	461.47	.2	411.52
.5	891.86	.5	722.85	.5	607.62	.5	524.02	.5	460.60	.5	410.82
.8	888.62	.8	720.71	.8	606.11	.8	522.90	.8	459.73	.8	410.13
69.0	885.39	85.0	718.59	101.0	604.61	117.0	521.78	133.0	458.86	149.0	409.44
.2	882.19	.2	716.48	.2	603.11	.2	520.67	.2	458.00	.2	408.75
.5	879.02	.5	714.38	.5	601.62	.5	519.55	.5	457.14	.5	408.07
.8	875.97	.8	712.30	.8	600.14	.8	518.45	.8	456.28	.8	407.38
70.0	872.73	86.0	710.22	102.0	598.67	118.0	517.35	134.0	455.43	150.0	406.70
.2	869.63	.2	708.16	.2	597.20	.2	516.25	.2	454.58	.2	406.02
.5	866.54	.5	706.11	.5	595.75	.5	515.16	.5	453.73	.5	405.34
.8	863.48	.8	704.08	.8	594.29	.8	514.07	.8	452.89	.8	404.67
71.0	860.43	87.0	702.05	103.0	592.85	119.0	512.99	135.0	452.04	151.0	404.00
.2	857.41	.2	700.04	.2	591.41	.2	511.91	.2	451.21	.2	403.33
.5	854.41	.5	698.03	.5	589.98	.5	510.84	.5	450.37	.5	402.66
.8	851.43	.8	696.04	.8	588.56	.8	509.77	.8	449.54	.8	401.99
72.0	848.47	88.0	694.06	104.0	587.14	120.0	508.71	136.0	448.71	152.0	401.33
.2	845.53	.2	692.09	.2	585.73	.2	507.65	.2	447.89	.2	400.67
.5	842.62	.5	690.14	.5	584.32	.5	506.59	.5	447.06	.5	400.01
.8	839.72	.8	688.19	.8	582.93	.8	505.54	.8	446.24	.8	399.35
73.0	836.84	89.0	686.25	105.0	581.54	121.0	504.49	137.0	445.43	153.0	398.70
.2	833.98	.2	684.33	.2	580.15	.2	503.45	.2	444.61	.2	398.04
.5	831.14	.5	682.42	.5	578.78	.5	502.41	.5	443.80	.5	397.39
.8	828.32	.8	680.51	.8	577.41	.8	501.38	.8	442.99	.8	396.74
74.0	825.52	90.0	678.62	106.0	576.04	122.0	500.35	138.0	442.19	154.0	396.10
.2	822.74	.2	676.74	.2	574.68	.2	499.32	.2	441.39	.2	395.45
.5	819.98	.5	674.87	.5	573.33	.5	498.30	.5	440.59	.5	394.81
.8	817.23	.8	673.00	.8	571.99	.8	497.28	.8	439.79	.8	394.17
75.0	814.51	91.0	671.00	107.0	570.65	123.0	496.27	139.0	439.00	155.0	393.53
.2	811.80	.2	669.31	.2	569.31	.2	495.26	.2	438.21	.2	392.90
.5	809.11	.5	667.48	.5	567.99	.5	494.26	.5	437.42	.5	392.26
.8	806.43	.8	665.66	.8	566.67	.8	493.26	.8	436.63	.8	391.63
76.0	803.78	92.0	663.85	108.0	565.35	124.0	492.26	140.0	435.85	156.0	391.00
.2	801.14	.2	662.05	.2	564.05	.2	491.27	.2	435.07	.2	390.37
.5	798.52	.5	660.25	.5	562.74	.5	490.28	.5	434.30	.5	389.75
.8	795.92	.8	658.47	.8	561.45	.8	489.29	.8	433.52	.8	389.12

Table 9-6. Subtense--Continued.

$\angle$	DIST	$\angle$	DIST	$\angle$	DIST	$\angle$	DIST	$\angle$	DIST	$\angle$	DIST
173 0	352.42	181 0	336.77	189 0	322.43	197 0	309.26	205 0	297.12	213 0	285.88
.2	351.91	.2	336.30	.2	322.01	.2	308.87	.2	296.75	.2	285.54
.5	351.40	.5	335.77	.5	321.58	.5	308.48	.5	296.39	.5	285.21
.8	350.89	.8	335.37	.8	321.15	.8	308.08	.8	296.03	.8	284.87
174 0	350.38	182 0	334.91	190 0	320.73	198 0	307.69	206 0	295.67	214 0	284.54
.2	349.88	.2	334.44	.2	320.30	.2	307.30	.2	295.30	.2	284.20
.5	349.38	.5	333.98	.5	319.88	.5	306.91	.5	294.94	.5	283.87
.8	348.87	.8	333.52	.8	319.46	.8	306.52	.8	294.59	.8	283.53
175 0	348.37	183 0	333.07	191 0	319.04	199 0	306.14	207 0	294.23	215 0	283.20
.2	347.87	.2	332.61	.2	318.62	.2	305.75	.2	293.87	.2	282.87
.5	347.37	.5	332.15	.5	318.20	.5	305.36	.5	293.51	.5	282.54
.8	346.88	.8	331.70	.8	317.78	.8	304.98	.8	293.16	.8	282.21
176 0	346.38	184 0	331.25	192 0	317.37	200 0	304.60	208 0	292.80	216 0	281.88
.2	345.89	.2	330.79	.2	316.95	.2	304.21	.2	292.45	.2	281.55
.5	345.40	.5	330.34	.5	316.54	.5	303.83	.5	292.10	.5	281.33
.8	344.91	.8	329.89	.8	316.12	.8	303.45	.8	291.74	.8	280.90
177 0	344.42	185 0	329.45	193 0	315.71	201 0	303.07	209 0	291.39	217 0	280.57
.2	343.93	.2	329.00	.2	315.30	.2	302.69	.2	291.04	.2	280.25
.5	343.44	.5	328.55	.5	314.89	.5	302.31	.5	290.69	.5	279.92
.8	342.96	.8	328.11	.8	314.48	.8	301.95	.8	290.34	.8	279.60
178 0	342.47	186 0	327.66	194 0	314.08	202 0	301.56	210 0	289.99	218 0	279.28
.2	341.99	.2	327.22	.2	313.67	.2	301.18	.2	289.65	.2	278.95
.5	341.55	.5	326.78	.5	313.26	.5	300.81	.5	289.30	.5	278.63
.8	341.03	.8	326.34	.8	312.86	.8	300.44	.8	288.96	.8	278.31
179 0	340.55	187 0	325.90	195 0	312.46	203 0	300.06	211 0	288.61	219 0	277.99
.2	340.07	.2	325.46	.2	312.05	.2	299.69	.2	288.27	.2	277.67
.5	339.59	.5	325.03	.5	311.65	.5	299.32	.5	287.92	.5	277.35
.8	339.12	.8	324.59	.8	311.25	.8	298.95	.8	287.58	.8	277.03
180 0	338.65	188 0	324.16	196 0	310.85	204 0	298.58	212 0	287.24	220 0	276.72
.2	338.17	.2	323.73	.2	310.45	.2	298.22	.2	286.90	.2	276.40
.5	337.70	.5	323.29	.5	310.06	.5	297.85	.5	286.56	.5	276.08
.8	337.23	.8	322.86	.8	309.66	.8	297.48	.8	286.22	.8	275.77

Section III. RECIPROCAL LAYING

9-6. General

Reciprocal laying is a procedure by which the 0-3200 line of one instrument and the 0-3200 line of another instrument are laid parallel. When the 0-3200 lines of an aiming circle and a panoramic telescope are parallel and the piece has been properly boresighted, the tube of the piece is parallel to both 0-3200 lines. The principle of reciprocal laying is based on the geometric theorem that if two parallel lines are cut by a transversal, the alternate interior angles are equal. The parallel lines are the 0-3200 lines of the instruments and the transversal is the line of sight between the two instruments. The alternate interior angles are the equal deflections placed on the instruments (fig 9-6).

9-7. Procedures

a. After the 0-3200 line of the aiming circle has been established parallel to the direc-

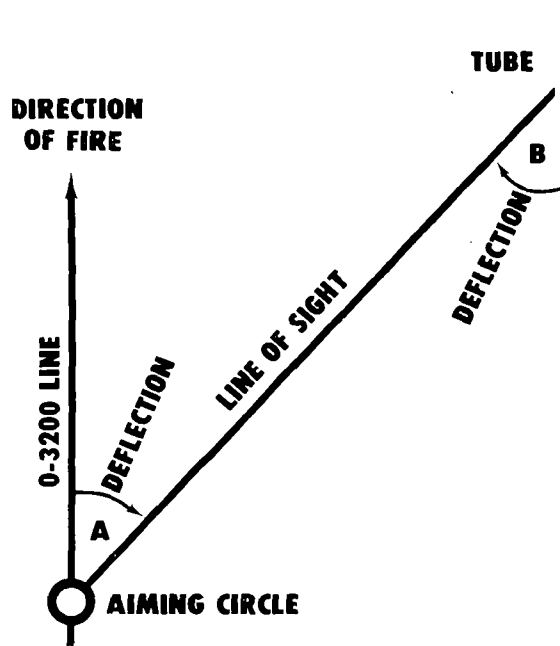


Figure 9-6. Principle of reciprocal laying.

tion of fire, the instrument operator, using the upper motion, sights on the lens of the panoramic telescope, reads the deflection on the azimuth and azimuth micrometer scales, and announces it to the gunner on the piece. *IF THE WEAPONS ARE EQUIPPED WITH M12-SERIES SIGHTS, DEFLECTION CANNOT EXCEED 3200 MILS*, therefore you may have to read the red numbers on the aiming circle. The gunner sets off the announced deflection on the panoramic telescope and orders the weapon to be shifted and/or traverses the tube by using the traversing handwheel until the line of sight through the panoramic telescope is again on the reflector of the aiming circle.

b. Because the panoramic telescope is offset laterally from the axis about which the carriage of the weapon is moved, the panoramic telescope is displaced horizontally. When the telescope has been sighted on the aiming circle, the gunner reports *READY FOR RECHECK* and the instrument operator again sights on the lens of the telescope and reads and announces the deflection. This procedure is repeated until the gunner reports a difference of 0 mils between successive deflections. The piece has then been laid reciprocally.

c. The last deflection announced to each weapon should be recorded by the instrument operator in the event it is needed by the FDC in computing position corrections.

d. In some cases, all pieces will not be able to see the aiming circle and one piece will be used to lay the others. If weapons are equipped with the M100-series panoramic telescopes, the readings between any two weapons will be 3200 mils apart. To prevent confusion, the gunner on the laying piece should add or subtract 3200 mils from his reading before announcing it to another howitzer. If the howitzer to which the laying gunner is referring is on his left, the gunner must add 3200, if it is on his right, he must subtract 3200.

e. In order of decreasing accuracy, the methods available to lay the battery are--

(1) *M2 aiming circle method using the orienting angle*. This method requires that a

known azimuth be established by the battalion survey section or by use of one of the hasty survey techniques discussed in section II.

(2) *M2 aiming circle method using the magnetic needle*. This method should be used only when surveyed data cannot be established.

(3) *M2 compass method*.

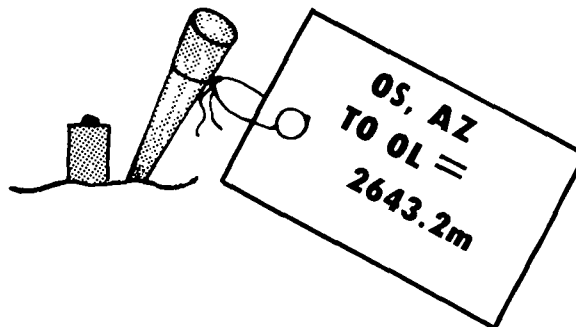
f. In addition, two methods of laying without the aiming circle (for emergency missions) are used. They are--

(1) *The aiming point-deflection method*.

(2) *The howitzer backlay method*.

9-8. Laying By Orienting Angle

a. To lay the battery by orienting angle, an orienting line must be established. The XO may be given the orienting angle by the survey section or he may find the information on a tag attached to the stake marking the orienting station (OS).



b. Using the plumbline, he sets up the aiming circle over the small stake. The large stake points toward the end of the orienting line (EOL). The XO can compute the orienting angle (fig 9-7) by subtracting the azimuth of fire from the azimuth of the orienting line. He uses the upper motion to set the orienting angle on the aiming circle and uses the lower motion to sight the aiming circle on the EOL. The 0-3200 line is now parallel to the azimuth of fire. A complete example follows.

(1) The battery is being laid. The orienting angle is 2500. Set up the aiming circle over the orienting station.

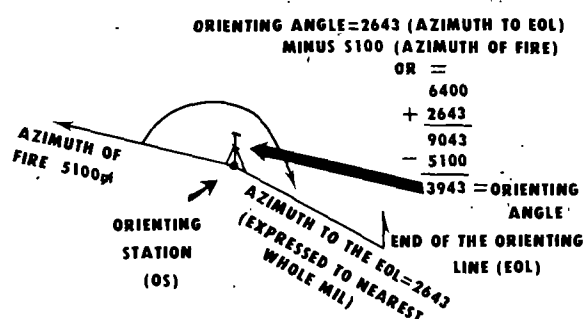


Figure 9-7. Computation of orienting angle.

(2) Turn the *UPPER* motion of the aiming circle until the index is opposite 2500--the 2500 on the half of the azimuth scale that has one row of black numbers only.

(3) Making certain that the index remains at 2500, use the *LOWER* motion and sight on the EOL. The line of sight now coincides with the orienting line. The 0-3200 line of the aiming circle is in the desired direction of fire.

(4) After the 0-3200 line of the aiming circle has been established in the desired direction of fire, the next step is to lay the battery reciprocally using the upper motion. This makes the tubes of the howitzers parallel to the 0-3200 line of the instrument, and thus oriented on the azimuth of fire.

ALWAYS VERIFY THE DIRECTION OF FIRE BY MEASURING THE AZIMUTH OF THE ORIENTING LINE OR BY MEASURING THE AZIMUTH OF FIRE AND COMPARING IT WITH THE COMPUTED AZIMUTH OF FIRE.

9-9. Laying By Grid Azimuth

If surveyed data are not available and simultaneous observation is not possible, the next best method of orienting the aiming circle is to use the magnetic needle.

a. To orient the aiming circle on a grid azimuth using the magnetic needle--

(1) Determine the instrument reading to be placed on the instrument by subtracting the azimuth of fire from the declination constant of the aiming circle (adding 6400 mils to the declination constant if necessary).

(2) Using the *UPPER* motion, place

this value on the aiming circle.

(3) Sight on magnetic north by centering (with the *LOWER* motion) the magnetic needle.

b. The next step is to lay the battery parallel, using the *UPPER* motion. Because laying by azimuth involves the use of the magnetic needle of the aiming circle, the instrument must be set up where it is free from magnetic attractions. The minimum distances that should be observed are--

Powerlines and electronic equipment 150 meters.
Railroad tracks, artillery*, tanks, and vehicles 75 meters.
Barbed wire, personal weapons, and small metallic objects 10 meters.

*These distances apply to all calibers of cannon weapons.

The following is an example of laying the battery by grid azimuth:

(1) The command to lay the battery on azimuth 5350 has been received. The declination constant of the aiming circle is 200 mils.

(2) Subtract the azimuth of fire from the declination constant. Since you cannot subtract the larger number (5350 mils) from the smaller number (200 mils), you must add 6400 mils to the smaller number. Thus, $6400 + 200 = 6600$ mils; $6600 - 5350 = 1250$. The horizontal, clockwise angle from the desired direction of fire to magnetic north (aiming point) is 1250 mils (fig 9-8).

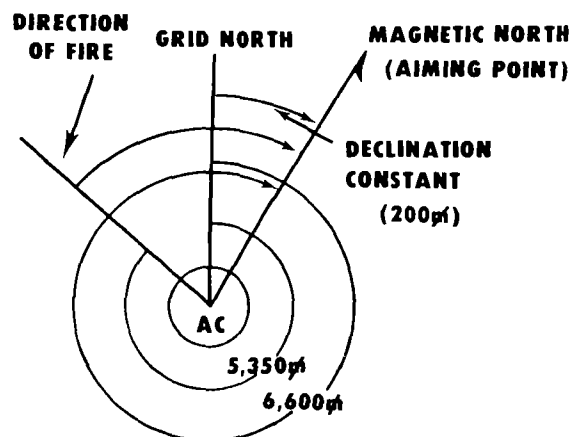


Figure 9-8. Principles of laying by grid azimuth.

(3) With the single 0 of the aiming circle nearest you and the 0-3200 line pointing generally in the direction of azimuth 5350, use the *UPPER* motion to set off 1250.

(4) Making certain that the index remains at 1250, center the magnetic needle by using the *LOWER* motion. This action places the 0-3200 line of the aiming circle in the desired direction of fire; i.e., on grid azimuth 5350 (fig 9-9).

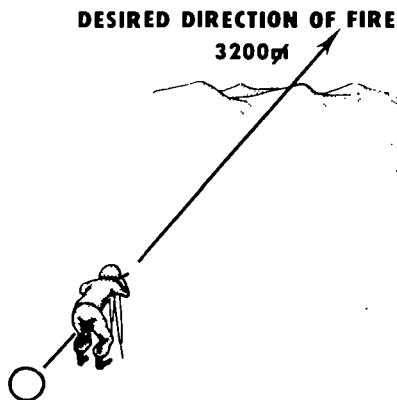


Figure 9-9. Relationship of 0-3200 line to instrument operator.

(5) After establishing the 0-3200 line of the aiming circle on grid azimuth 5350, lay the battery reciprocally by using the *UPPER* motion. This procedure places each howitzer tube on grid azimuth 5350.

9-10. Commands

The following commands are used in laying a battery with an aiming circle. The deflections announced are examples only, except for the one used in the last command. For brevity, only the exchange between the instrument operator and the gunner of number 3 are given.

Instrument operator:

BATTERY ADJUST,
AIMING POINT
THIS INSTRUMENT.

(All gunners identify the aiming point. Normally, pieces are laid in the order of their readiness.)

Gunner of #3:

NUMBER 3, AIMING
POINT IDENTIFIED.

(Each gunner gives a similar response. Using the *UPPER* motion, the instrument operator turns the head of the aiming circle until the line of sight is on the telescope of the number 3 piece and reads the azimuth and azimuth micrometer scales.)

Instrument operator:

NUMBER 3,
DEFLECTION 3091.

Gunner of #3:

NUMBER 3,
DEFLECTION 3091.

(The gunner then sets the deflection on his sight and traverses the weapon until he is sighted back on the aiming circle.)

Gunner of #3:

NUMBER 3,
READY FOR RECHECK.

(The instrument operator again turns the head of the aiming circle until the line of sight is on the telescope of the number 3 piece and announces the deflection.)

Instrument operator:

NUMBER 3,
DEFLECTION 3093.

(This indicates a difference of 2 mils from the original deflection of 3091, which the

gunner now has on the panoramic telescope. The gunner sets 3093 on the telescope and again traverses the tube until he is sighted on the aiming circle. Meanwhile, the instrument operator may or may not proceed with the laying of the other pieces. As a general rule, when the gunner of any piece announces a difference of 10 mils or less, the instrument operator continues to lay that particular piece until it is laid.)

Gunner of #3:

NUMBER 3,
DEFLECTION 3093,
2 MILS.

The gunner then announces--

NUMBER 3, READY
FOR RECHECK.

Instrument operator:

NUMBER 3,
DEFLECTION 3093.

Gunner of #3:

NUMBER 3,
DEFLECTION 3093,
0 MILS.

(Rechecking of each piece must continue in this manner until the deflection announced by the instrument operator and the deflection on the panoramic telescope are identical.)

Instrument operator:

NUMBER 3
IS LAID.

9-11. Laying The Battery Without An Aiming Circle

If an operational aiming circle is not available, the following methods of laying the battery may be used. The methods in *b* and *c* below are recommended for emergency situations, in which time is of the essence.

a. M2 Compass method.

(1) Place the M2 compass on a steady object away from magnetic attractions and where it can be used as an aiming point for the base piece. The aiming circle tripod, if available, is excellent for this purpose.

(2) Measure the azimuth to the panoramic telescope of the base piece. Compute a deflection by subtracting the announced azimuth of fire from the azimuth measured to the panoramic telescope of the base piece (adding 6400 mils, if necessary.)

(3) Command--

BASE PIECE ADJUST or
NUMBER (so-and-so) ADJUST,
AIMING POINT THIS INSTRUMENT,
DEFLECTION (so much).

The gunner sets the announced deflection on the sight, moves the weapon and/or traversing mechanism until he is sighted on the instrument, and announces--

NUMBER (so-and-so) AIMING
POINT IDENTIFIED, DEFLECTION
(so much).

The instrument operator commands--

BASE PIECE IS LAID, BATTERY
ADJUST, ON BASE PIECE LAY
PARALLEL (or ON NUMBER (so-and-so) LAY PARALLEL).

(4) The gunner of the base piece then reciprocally lays the other pieces. He uses the panoramic telescope and the procedure explained in paragraph 9-7.

b. Aiming point-deflection method. The aiming point and deflection method is used primarily for a rapid occupation of position; however, it can be used for a deliberate occupation in the absence of an aiming circle or an M2 compass. The XO should lay the base piece and then have the base piece gunner lay the battery reciprocally.

(1) Determine the azimuth from the battery center to a distant aiming point (DAP). To compute a deflection, subtract the *back-azimuth* of fire from the azimuth determined to the distant aiming point.

(2) To lay the battery, command--

BATTERY ADJUST, AIMING POINT (so-and-so) (location), DEFLECTION (so much).

(3) Each gunner sets off the announced deflection, sights on the aiming point by moving the carriage and traversing mechanism, and then announces--

NUMBER (so-and-so), AIMING POINT IDENTIFIED, DEFLECTION (so much).

(4) When all sections have so reported, command--

THE BATTERY IS LAID.

WHEN THE BATTERY IS LAID BY THE AIMING POINT AND DEFLECTION METHOD, THE SHEAF TENDS TO CONVERGE IF THE AIMING POINT IS TO THE FRONT AND TENDS TO DIVERGE IF THE AIMING POINT IS TO THE REAR. THEREFORE, IT IS PREFERABLE TO USE AN AIMING POINT ON THE FLANK.

c. Howitzer backlay method. In an emergency, when time is critical and a DAP is not available, the howitzer backlay method may be used. With training and practice, the battery can perform this method as accurately and quickly as the aiming point-deflection method. Upon receipt of a fire mission, the XO pulls into a firing position and alines the front of his vehicle roughly on the azimuth of fire. His driver assists him in alining two stakes and the battery is laid by the following procedure:

(1) The XO drives in the rear stake and uses the M2 compass to aline the far stake on the azimuth of fire. He then drives in the far stake. (Distance between stakes should be equal to the length of the howitzer.) (A)

(2) The XO guides the base piece into position and alines it parallel to the stakes. With the tube still in the center of traverse position, the base piece fires the first round with the quadrant and charge determined by the XO or FDC. (B)

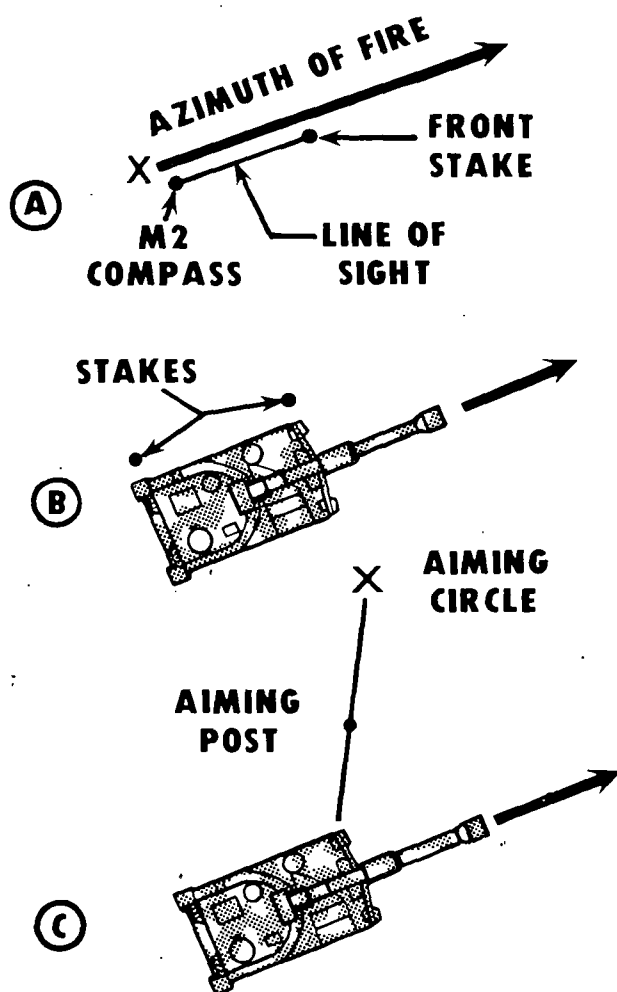
(3) While the base piece is firing the first round, one man sets up the aiming circle in the appropriate position to lay the rest of the battery. After the first round is fired, the instrument operator commands--

BASE PIECE, AIMING POINT THIS INSTRUMENT REFER.

The gunner on the base piece refers to the aiming circle and replies--

BASE PIECE, AIMING POINT IDENTIFIED, DEFLECTION (so much).

The instrument operator places the referred reading on the aiming circle, sights on the base piece with the lower motion, and then lays the remainder of the battery by standard procedures. The gunner on the base piece places an aiming post halfway between himself and the aiming circle to be used as an aiming point, and the remaining pieces emplace collimators. (C)



9-12. Establishing Aiming Points

a. Under normal circumstances, after the battery has been laid, the crew of each piece is directed to set up the collimator or aiming posts before the tube is moved. The deflections at which the aiming points are established are recorded by the gunner. Furthermore, the direction in which the battery is initially laid and the corresponding deflection are used as references from which the FDC can derive firing deflections for future targets.

b. The collimator is the primary aiming point and is placed 4 to 15 meters from the sight of the weapon. (Best results are obtained with the collimator from 6 to 12 meters from the sight.) If possible, place the colli-

mator under cover to the left or left front of the weapon. Be sure that the collimator is emplaced so that the power cable will reach the weapon (SP weapons only). When aiming posts are used, the far aiming post should be placed 100 meters from the piece and the near aiming post *must* be placed halfway between the piece and the far aiming post.

c. As soon as the battery is laid and the aiming point(s) (is) are emplaced, the XO should have the gunners of all pieces refer to a distant aiming point if one is available. This DAP can be used as the primary aiming point if something happens to the collimator or aiming posts. For example, the XO may command--

AIMING POINT, STEEPLE RIGHT FRONT, REFER, RECORD REFERRED DEFLECTION.

Each gunner refers to the steeple and records the deflection for future use.

9-13. Verifying Laying For Direction

a. After the battery has been laid, there are certain checks which should be made to insure that no weapon has been laid in error and that the pieces have been laid parallel and in the proper direction. To check parallelism, each gunner checks reciprocally with at least one other piece. If the deflections used by the gunners agree, the pieces are parallel. *Caution must be used in checking with the M100 series sights, since the reading from one sight to another will differ by 3200 mils.* Further, one of the firing battery supervisors should walk the line of metal and visually check the parallelism of the tubes.

b. As soon as time permits, the following check should be made:

(1) With another aiming circle (if available) command--

NUMBER (so-and-so), AIMING POINT THIS INSTRUMENT REFER.

(2) The gunner of the piece indicated announces AIMING POINT IDENTIFIED, turns the sight of the piece until the line of sight is on the designated instrument, and announces the reading on the sight scale as--

NUMBER (so-and-so), DEFLECTION (so much).

(3) The instrument operator sights on the panoramic telescope of the designated piece.

(4) If the deflection read by the gunner does not agree with that read from the instrument, the instrument operator can correct it by giving the gunner the proper deflection and re-laying the weapon.

9-14. Laying By Aircraft, High Airburst, Or Flare

a. The battery may be laid initially for direction by sighting with an instrument on an aircraft, a high airburst, or a flare. This procedure is valid when the entire battalion is placed on a common direction.

b. When no visible point is suitable for use as an aiming point, an *aircraft* may fly over the battery position toward, or away from, a point in the target area to indicate an azimuth of fire.

c. If a *high airburst* or a *flare* is to be used, it should be fired over the target area. The high airburst is fired by another unit, that has been laid previously for direction. The flare may be fired by an air observer or a ground observer.

d. To lay the battery by aircraft, high airburst, or flare, use the following procedure:

(1) Set up the aiming circle where it can be used as an aiming point by all pieces.

(2) Zero the azimuth scale and azimuth micrometer scale and, using the lower motion, align the vertical hairline on the aircraft, airburst, or flare.

(3) Using the upper motion, lay the pieces reciprocally by standard procedures.

9-15. Training

a. The battery must be prepared to deliver fire as quickly as possible after getting to the firing position. This means that the laying process must be completed as quickly as possible. Personnel who lay the battery must be--

**FAST
and
ACCURATE.**

This requires training.

b. As a minimum, the following personnel should know how to lay the battery:

- All officers.
- The chief of firing battery.
- The gunnery sergeant.
- The first sergeant.
- All howitzer section chiefs.

c. Training should start initially in a local training area. A card made up in the format indicated in table 9-7 should be issued to each trainee to use until he has mastered the math and procedural steps. Trainees should be encouraged to use the memory aids to jog their memories.

d. GTA 6-1, the firing battery supervisors ready reference square, is very handy for trainees to use after they have been trained in laying procedures.

e. How to avoid the common mistakes and malpractices discussed in appendix G should be emphasized.

f. In order to maximize training effectiveness, a howitzer/gun with a crew of at least a gunner and an assistant gunner should be provided for each trainee. Radio or wire communications should be established between the aiming circle and the howitzer. Use of proper commands should be heavily emphasized by the trainer.

g. As soon as the trainee has mastered the math and procedural steps for all methods of laying, he should be drilled frequently to develop speed in--

- Setting up and leveling the aiming circle.
- Determining initial instrument readings.
- Centering the magnetic needle of the aiming circle.
- Scaling azimuths from a map.

•Accurately measuring azimuths with the M2 compass. This will develop the proficiency needed to lay by the howitzer back-lay method also.

h. In order to maintain proficiency and develop confidence, the commander should designate various people to lay the battery during field training exercises.

Table 9-7. How To Lay The Battery.

WITH THE M2 AIMING CIRCLE		
If survey is available, you must use the azimuth (AZ) to the end of the orienting line (EDL) and AZ of fire --		
SEQUENCE	MEMORY AID	MATH AND AIMING CIRCLE STEPS
Do this FIRST	Take the fire out of Old Lady	• Az to EDL - az of fire = Orienting Angle (OA).
Do this SECDND	U	• Set the DA on the aiming circle with the Upper motion
Do this THIRD	L	• Sight on the EDL with the Lower motion
Do this LAST	U	• Sight on the pantel with the Upper motion
REMEMBER--ULU		
If no survey is available, but the battalion survey section can man a master station to perform a simultaneous observation--		
SEQUENCE	STEPS	
Do this FIRST	• Set up and level the aiming circle over the orienting station. • Set 0.0 mils on the aiming circle horizontal scales.	
Do this SECDND	• Identify the predetermined celestial object; with the LOWER motion, sight and track the object until the master station announces TIP.	
Do this THIRD	• Depress the telescope of the aiming circle and place the EDL squarely along the aiming circle line of sight. Record the azimuth that is announced by the master station.	
Do this FDURTH	• Track the celestial object with the UPPER motion until the master station announces TIP.	
Do this FIFTH	• Read and report to the master station the angle that was measured (read the horizontal scales).	
Do this SIXTH	• Wait for verification from the master station to insure that the observation was within tolerance.	
Do this LAST	• The azimuth recorded in the third step is the azimuth to the EOL and is used in computing the orienting angle. The battery is then laid by the orienting angle method.	

Table 9-7. How To Lay The Battery--Continued.

If no survey is available and simultaneous observation is not possible, you must use the declination constant (DC) and the AZ of fire.

SEQUENCE	MEMORY AID	MATH STEPS
Do this FIRST	S A D	• Subtract the Az of fire from the DC.
Do this SECOND	U	• With the Upper motion, set the remainder on the aiming circle.
Do this THIRD	L	• With the Lower motion, center magnetic needle.
Do this LAST	U	• With the Upper motion, sight on the panel.

REMEMBER--SAD-ULU

WITH THE M2 COMPASS

You must use the AZ you measure to the base piece with the compass and the AZ of fire.

SEQUENCE	MEMORY AID	MATH STEPS
Do this FIRST	S A M	• Subtract the Az of fire from the AZ Measured to base piece.
Do this LAST		• Using proper commands, announce the resulting deflection.

REMEMBER--SAM

BY THE AIMING POINT-DEFLECTION METHOD

You must use the AZ to the distant aiming point (DAP) and the AZ of fire--

SEQUENCE	MEMORY AID	MATH STEPS
Do this FIRST	AP-BAF	• Aiming Point azimuth - (minus) the Back-Azimuth of Fire.
Do this LAST		• Using the proper command, announce the resulting deflection.

REMEMBER--AP-BAF

Table 9-7. How To Lay The Battery--Continued.

BY THE HOWITZER BACKLAY METHOD	
Using the M2 compass, you must align two stakes on the azimuth of fire and position the base piece parallel to the stakes--	
SEQUENCE	STEPS
Do this FIRST	Set up the aiming circle where it can be seen by all the pieces and level it.
Do this SECOND	After the base piece fires the first round, have the gunner refer to the aiming circle.
Do this THIRD	With the UPPER motion, place the referred deflection on the aiming circle.
Do this FOURTH	With the LOWER motion, sight on the panoramic telescope of base piece.
Do this LAST	With the UPPER motion, lay the remainder of the battery.

Section IV. DETERMINING AND REPORTING LAY DATA

9-16. Checks

a. The fire direction center will often require a check on weapon direction for various operations (construction of firing charts, checks on laying, checks on data fired, etc.). These checks are normally made immediately following a registration.

b. Two methods of reporting (paragraphs 9-17 and 9-18) reveal any sloppy procedures; e.g., taking up the sight picture improperly or failing to level bubbles. *Measuring* provides a check on the accuracy of the battery location and lay. When errors are detected, the FDC should modify the adjusted data determined during a registration as appropriate.

IT IS CRITICAL THAT THE
TUBE OF THE REGISTERING
PIECE NOT BE MOVED PRIOR
TO THESE CHECKS.

9-17. Reporting Adjusted Deflection

When the command--

REPORT ADJUSTED
DEFLECTION

is received after registration, the XO goes to the base piece and verifies that the sight mount is level and that the correct sight picture exists. If the sight picture is incorrect, the XO corrects it by moving the head of the sight. Then he reads the deflection from the sight of the base piece and reports to FDC--

ADJUSTED DEFLECTION (so much).

9-18. Reporting Adjusted Azimuth Or Orienting Angle

a. After a registration, the S3 may command--

REPORT ADJUSTED AZIMUTH

(or orienting angle if the battery is laid by orienting angle) before *END OF MISSION* is announced to the guns. The adjusted deflection of the piece is determined at this time and noted. Then the XO determines the difference between this deflection and the initial deflection. He applies that difference to the azimuth or orienting angle on which the piece was previously laid and reports--

ADJUSTED AZIMUTH (or ORIENTING ANGLE) (so much).

AN INCREASE IN DEFLECTION CAUSES AN EQUAL DECREASE IN AZIMUTH AND AN EQUAL INCREASE IN ORIENTING ANGLE.

b. Here's an example: The battery is laid on azimuth 5000, deflection 2800. After firing, the adjusted deflection was 2915. The S-3 commands--

REPORT ADJUSTED AZIMUTH.

(1) Deflection 2800 to deflection 2915 equals an increase of 115.

(2) Subtract 115 from the azimuth of fire. $5000 - 115 = 4885$.

(3) The XO reports--

ADJUSTED AZIMUTH 4885.

9-19. Measuring The Azimuth Of The Direction Of Fire

When the command--

MEASURE THE AZIMUTH

is received, the direction of the tube of the base piece is actually measured with an aiming circle. The procedure for measuring the azimuth is as follows:

a. Orient the 0-3200 line of the aiming circle generally parallel to the tube of the piece.

b. Command the gunner of the base piece to refer the sight to the aiming circle and announce the deflection.

c. With the upper motion, set the announced deflection on the aiming circle. *Remember, if the weapon is equipped with an M12-series sight, you may have to use the red numbers.* If, after setting the reading on the aiming circle, the line of sight is roughly toward the piece, you have used the right numbers.

d. With the lower motion, turn the telescope until the vertical hairline is on the sight of the piece.

THE 0-3200 LINE OF THE AIMING CIRCLE IS NOW PARALLEL TO THE TUBE OF THE PIECE.

e. Release the magnetic needle and, with the upper motion, center it.

f. Subtract the final instrument reading from the declination constant of the aiming circle.

g. Report the result as--

AZIMUTH (so much).

Here's an example:

FDC:

MEASURE THE AZIMUTH.

Instrument operator:

NUMBER 3 (base piece), AIMING POINT THIS INSTRUMENT, REFER.

Gunner:

NUMBER 3, AIMING POINT
IDENTIFIED, DEFECTION 2415.

Instrument operator:

NUMBER 3, DEFECTION 2415.

The declination constant is 200 mils. The instrument operator now centers the magnetic needle and determines his instrument reading to be 1560. He subtracts this from the declination constant and reports--

AZIMUTH 5040 MILS.

9-20. Measuring The Orienting Angle

The orienting angle is measured in the same manner as the azimuth except that--

a. Instead of centering the magnetic needle, the instrument operator, with the upper motion, sights the instrument on the end of the OL.

b. The final reading is the orienting angle (see fig 9-10).

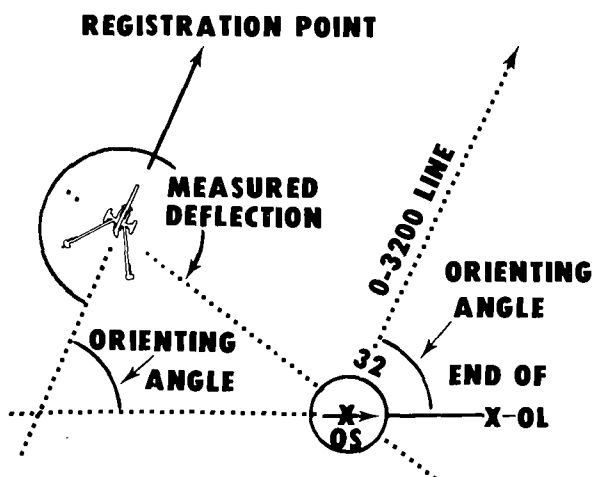


Figure 9-10. Measuring the orienting angle with the aiming circle.

9-21. Correction Of Boresighting Error After Registration

a. Tactical considerations may necessitate registration before sight tests and adjustments can be made. In such cases the pieces must be boresighted at the most practicable time, usually during a lull in firing. If boresighting discloses that the 0-3200 line of the sight is not parallel to the tube, corrective measures must be taken and reported to the fire direction center.

b. When a deflection is read from a sight or when an azimuth is measured, the deflection or azimuth determined is that of the 0-3200 line as read from the azimuth counter. *Only if the weapon is properly boresighted is the deflection or azimuth that of the tube.* When the FDC commands--

MEASURE THE AZIMUTH (ORIENTING ANGLE),

the azimuth (orienting angle) of the tube is desired. Therefore, if the weapon is not properly boresighted, the azimuth (orienting angle) measured is inaccurate by the amount of the error in boresighting.

c. At the first opportunity, weapons are boresighted. The azimuth counter is used during boresighting. The tube is pointed at the aiming point (either at a distant aiming point, at the appropriate "butterfly" on the test target, or at deflection 3200 when using an alinement device), and the sight is zeroed. If the sight is pointed to the right of the appropriate aiming point, the tube is pointed to the left of the 0-3200 line of the sight. It follows that any azimuth measured prior to this time was greater than the azimuth of the tube and that any orienting angle measured was smaller than the tube orienting angle. If the sight is pointed to the left of the appropriate aiming point, the measured azimuth is less than the azimuth of the tube and the measured orienting angle is larger than that of the tube. The amount of the error is determined by referring the sight to the aiming point and reading the deflection. This de-

flection is compared with 3200, and the difference is the amount of the error in boresighting. The previously determined azimuths or orienting angles are corrected, boresighting is completed, and the actions taken are reported.

Example 1: A battery has occupied a position. Before the base piece can be boresighted a registration is conducted. At the conclusion of the registration, the executive officer determines 2595 to be correct on the azimuth counter (3195 on the reset counter) and measures an azimuth of 1800. A short time later, the piece is boresighted. With the tube pointed at the appropriate aiming point and the azimuth counter reading 3200, the sight is pointed to the right of the aiming point. The XO then refers the sight to the aiming point and reads a deflection of 3192 mils. The tube is pointed 8 mils to the left of the 0-3200 line of the sight (①, fig 9-11). Therefore, the azimuth of the tube after registration is 1792 (1800 - 8). When the weapon is boresighted, a deflection of 2595 (3195 on the reset counter) will not point the tube on azimuth 1792. To correct this error, the XO adds 8 mils to the deflection and it becomes 2603 as read on the azimuth counter (3203 on the reset counter) (②, fig 9-11). The XO then directs the gunner to return the base piece to the initial lay by setting the azimuth counter deflection at 2600 and the reset counter at 3200. After correcting the boresighting, the XO reports--

ERROR OF 8 MILS IN BORESIGHTING ON BASE PIECE, CORRECT AZIMUTH WHEN LAID ON REGISTRATION POINT IS 1792, CORRECT ADJUSTED DEFLECTION 3203, BORESIGHTING HAS BEEN CORRECTED.

Example 2: Assume that in example 1 an orienting angle of 853 mils was measured. After the 8-mil error in boresighting is determined, the corrected orienting angle is 860 mils (fig 9-12). The XO reports--

ERROR OF 8 MILS, CORRECT ORIENTING ANGLE IS 861, CORRECT ADJUSTED DEFLECTION 3203, BORESIGHTING HAS BEEN CORRECTED.

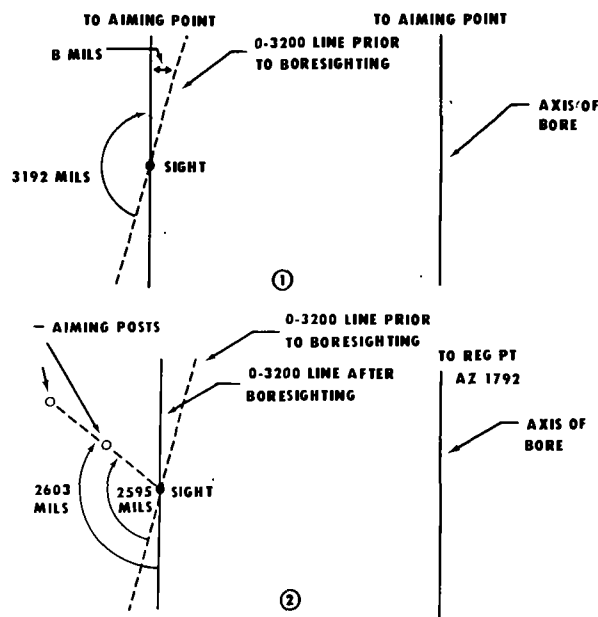


Figure 9-11. Example of error revealed by boresighting.

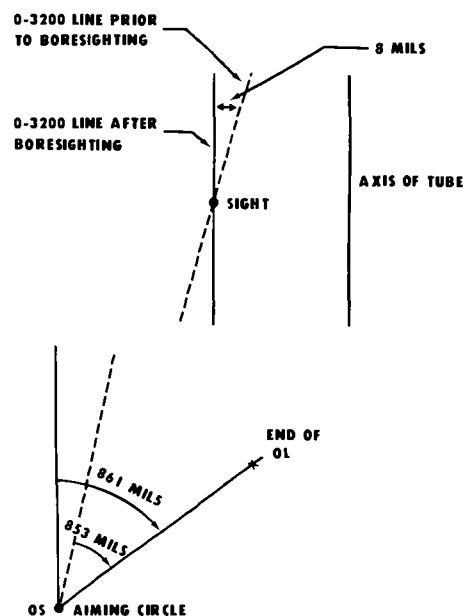


Figure 9-12. Example of error in orienting angle due to error in boresighting.

9-22. Site By Firing (Exec's High Burst)

Upon completion of an observed firing chart registration with fuze time, the S3 may command--

OBSERVE HIGH BURST, MEASURE
ANGLE OF SITE, 3 ROUNDS,

followed by the adjusted data. This indicates that the S3 desires that the battery FDC report the observed angle of site to the mean burst center of three rounds. The procedure for measuring the angle of site is as follows:

a. Place the aiming circle near the base piece and have the base piece lay it reciprocally. The aiming circle is now oriented on the direction of fire.

b. Determine the angle of site necessary to place the burst of the rounds fired by the base piece above the crests. Place this value

on the vertical scales of the aiming circle.

c. Give the necessary commands to the base piece to place the bursts above any crests visible from the battery area.

d. Command the base piece to fire.

e. With the lower motion, place the *vertical* hairline of the aiming circle on the burst. Record the angle of site.

f. Fire two more rounds, and record the angle of site for each.

g. Report to the FDC the mean observed angle of site and the quadrant elevation fired.

9-23. Training

Training in the proper methods of measuring and reporting piece direction should be a part of training personnel to lay the battery. The personnel indicated in paragraph 9-15 should receive this training. Use a card like the one in table 9-8 to assist the trainee in remembering the procedural steps.

Table 9-8. How To Measure And Report Piece Direction.

HOW TO MEASURE THE ORIENTING ANGLE		
SEQUENCE	MEMORY AID	STEPS
Do this FIRST	U	With the Upper motion, place the deflection read to you by the gunner on your aiming circle.
Do this SECOND	L	With the Lower motion, sight on the howitzer panoramic telescope.
Do this THIRD	U	With the Upper motion, sight on the end of the orienting line.
THE READING IS THE ORIENTING ANGLE.		
TO MEASURE THE AZIMUTH OF FIRE		
SEQUENCE	MEMORY AID	STEPS
Do this FIRST	U	With the Upper motion, place the deflection read to you by the gunner on your aiming circle.
Do this SECOND	L	With the Lower motion, sight on the howitzer panoramic telescope.
Do this THIRD	U	With the Upper motion, center the magnetic needle.
Do this LAST	SID	Subtract the Instrument reading (on the aiming circle) from the Declication constant.
THE RESULT IS THE AZIMUTH OF FIRE.		
TO REPORT PIECE DIRECTION		
- Physically go to the howitzer. - Check to insure that the bubbles on the sight mount are level; if they are not, level them. - Check the sight picture, if it is incorrect, correct it by moving the head of the pantel only. DO NOT TRAVERSE THE TUBE. - Read and report the df on the pantel.		

CHAPTER 10

MINIMUM QUADRANT ELEVATION

Section I. INTRODUCTION

10-1. General

In training and in combat we must insure that artillery fire lands on the intended target—that it does not hit an intervening crest between the guns and the target. The XO is responsible for determining the lowest quadrant elevation that can be safely fired from his battery position and that will insure that projectiles clear all friendly crests visible from the battery position. The FDC must insure that rounds clear friendly intermediate crests. The computation procedures in this chapter can be used for both.

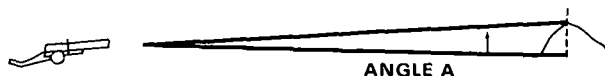
10-2. Elements of Computation

Whenever possible, the minimum quadrant elevation (min QE) Rapid Fire Tables (app F) should be used for computing minimum quadrant elevation. The XO, however, must be familiar with the elements that make up this computation and how they are determined. Step-by-step procedures for computing min QE (if the rapid fire tables CAN NOT be used) are in section II. Here's a general look at the elements that make up the computation.

a. *Range to crest* is the horizontal distance between the piece and the crest, expressed to the nearest 100 meters. Procedures for measurement are discussed in paragraph 10-4.



b. *Angle a* is the greatest angle of site to crest measured by all the weapons (para 10-3).

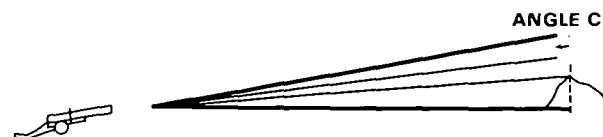


c. *Angle b* is the vertical angle corresponding to the required vertical clearance for friendly elements. For quick, time, and un-

armed VT fuzes, a vertical clearance of 5 meters is used. For armed VT fuzes, see paragraph 10-8.



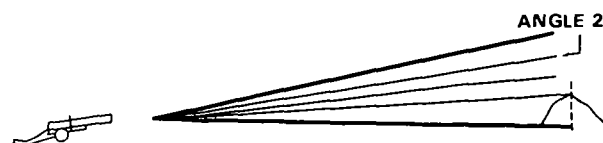
d. *Angle c* is the complementary angle of site (comp site). It is the comp site factor for the appropriate charge at the piece-to-crest range multiplied by the sum of angles a and b



e. *Angle 1*, site, is the sum of angles a, b, and c.

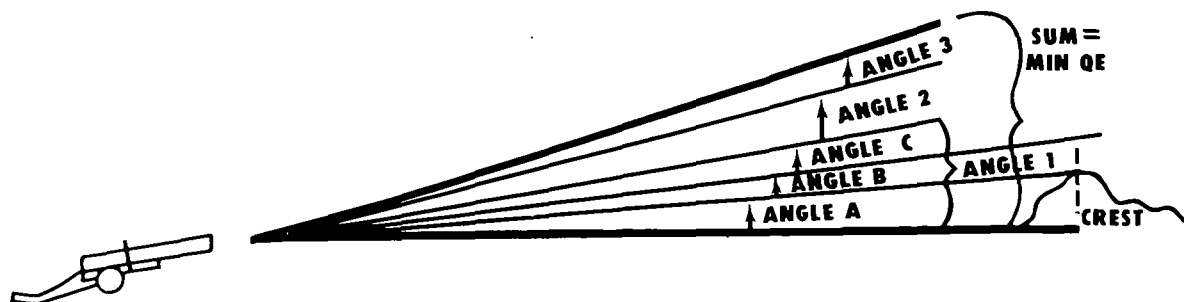


f. *Angle 2* is the elevation for the appropriate charge corresponding to the piece-to-crest range.



g. *Angle 3* is a safety factor equivalent to the value of 2 forks (from table F of the tabular firing tables) for the appropriate charge at the piece-to-crest range.

h. The sum of angles 1, 2, and 3 is the minimum quadrant elevation.



10-3. Measuring Angle of Site to Crest

As soon as his piece is laid, the chief of section measures the angle of site to the crest and reports it to the XO. To measure the angle of site to crest, the chief of section, sighting along the lowest element of the bore, has the tube traversed across the probable field of fire and has the tube elevated until the line of sight clears the crest at the highest point. He then centers all bubbles on the elevation mount and reads the angle of site to the crest from the elevation scale and micrometer scale. This angle may also be measured with a gunners quadrant placed on the quadrant seats. This angle of site is reported to the XO.

10-4. Measuring Range to Crest

The most commonly used methods of measuring range to crest are:

a. Mil relation. The mil relation is a particularly good method when the tactical situation permits its use. The mil relation method involves the use of the panoramic telescopes of the flank pieces, one aiming circle and one panoramic telescope, or two aiming circles. Usually, it is most practical to use the panoramic telescopes of the flank pieces. For example, the battery has been laid parallel and the paced distance between flank pieces is 150 meters (fig 10-1). The steps for the mil relation method are--

(1) The gunners of the flank pieces refer to exactly the same point on the crest.

(2) Each of the flank gunners announces the deflection to the point on the crest from his piece.

(3) The apex angle (angle X) is deter-

mined from these two deflections as indicated in figure 10-1.

(4) The range in meters to the crest is determined by dividing the battery front in meters times 1,000 by the apex angle in mils. The base may be measured by pacing or by subtense if the flank pieces are intervisible. See chapter 9 for details on the use of subtense.

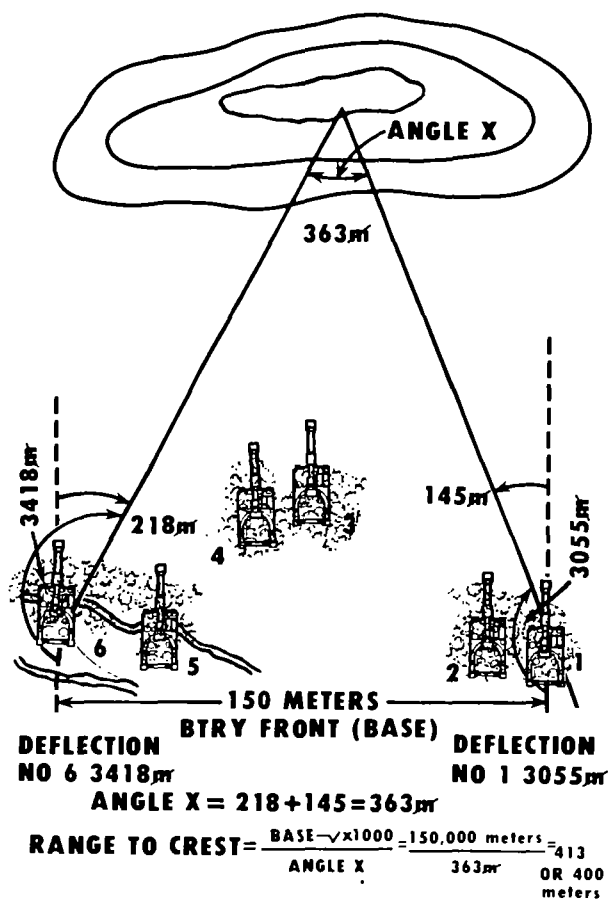


Figure 10-1. Determining piece-crest range by use of panoramic telescopes.

b. Taping is an accurate method; however, it is time consuming and is used only when time and terrain permit.

c. Map measurement is a fast, accurate method that is not affected by adverse terrain features. The chart operator plots the location of the position area, determines the highest point of the crest, and measures

the distance with the appropriate scale.

d. Pacing is a time-consuming method, dependent on the distance to the crest and the accessibility of the crest.

e. Estimation may be used when more accurate means are not feasible.

Section II. COMPUTATION OF DATA

10-5. Computation of Minimum Quadrant Elevation for Firing of Fuzes Other Than VT

a. The XO performs the computations indicated in this section if the sum of angles *a* and *b* exceeds 300 mils or if the rapid fire tables are not available. All angles are determined and expressed to the next higher whole mil. The following is an example of this computation. The range to crest is 1100 meters, the greatest angle of site to crest reported is +16 mils. The weapon is the 155-mm howitzer M109A1, and charge 3 green bag will be fired. The XO--

(1) Selects and records the greatest angle of site (angle *a*) reported by the chiefs of section. Angle *a* = +16 mils.

(2) Determines the value in mils of angle *b*, the vertical clearance angle. He uses the GST to divide the vertical clearance in meters (5 meters) by the piece-to-crest range in thousands (1.1). This value, read under the M gagepoint, is 4.6, which is *expressed to the next higher whole mil*. Angle *b* = +5 mils.

(3) Determines angle *c* (comp site) by multiplying the comp site factor corresponding to the piece-to-crest range (or the next higher listed range in table G of the TFT if that range is not listed) by the sum of angles *a* and *b*. Angle *a* + angle *b* = 21. The comp site factor corresponding to 1500 meters (range 1100 is not listed in table G) is +0.010. Therefore $+21 \times 0.010 = +0.210$. Once a value for comp site has been determined, it must be *expressed to the next higher whole mil*. Angle *c* = +1 mil.

(4) Determines angle 1 (site) by adding together angles *a*, *b*, and *c*. Angle 1 = +22 mils

(5) Determines elevation for the piece-to-crest range (angle 2). If this value is not a whole number, it is *expressed to the next higher whole mil* (73.4 expresses to 74). Angle 2 = +74 mils.

(6) Determines the value of 2 forks (table F of the TFT) at piece-to-crest range (angle 3). 2 forks = +2 mils.

(7) Adds angles 1, 2, and 3 to determine the Min QE.

$22 + 74 + 2 = 98 \text{ mils}$

b. A single narrow obstruction, such as a tree, that will mask only one piece at a time is not considered in computing minimum quadrant elevation. If a piece cannot be fired safely, it is called out of action. If the XO does not want to call the piece out of action, he may have the piece moved so that it can be fired safely or he may direct that the mask (obstruction) be removed.

10-6. Computation of Minimum Quadrant Elevation for Firing With VT Fuzes (low-angle fire)

a. The method of computing minimum quadrant elevation for firing a projectile fuzed with an M513 or M514 fuze, or modifications thereof, depends on the method in which the fuze is employed.

b. The variable time fuze is designed to arm 3 seconds prior to the time set on the fuze; however, some variable time fuzes have armed as early as 5.5 seconds prior to the time

set on the fuze. Because of the probability of premature arming, a safety factor of 5.5 seconds must be added to the time of flight to the point where arming is permitted. Since time on the setting ring is set to the whole second, the time determined is rounded up to the whole second, and this is the minimum safe time. A VT fuze can never arm earlier than 2 seconds time of flight.

c. In *noncombat* situations the XO determines the minimum safe time by adding 5.5 seconds to the time of flight to the minimum range line as shown on the safety card. The minimum quadrant elevation determined by the XO for fuzes quick and time is also valid for fuze VT, because firing the VT fuze at a fuze setting less than the minimum safe time is not authorized.

d. In *combat* situations the XO determines the minimum safe time and minimum quadrant elevation at the piece-to-crest range or the minimum arming range, *whichever is greater*.

e. When the projectile is to be fired with the VT fuze set at a time *less than the minimum safe time*, allowance must be made for vertical clearance of friendly elements. Vertical crest clearances for M513 and M514 VT fuzes fired over ordinary terrain are shown below.

Table 10-1. Vertical clearance.

WEAPON	VERTICAL CLEARANCE
105mm HOWITZER	80 METERS
155mm HOWITZER	100 METERS
8-INCH HOWITZER	150 METERS

f. If the M728 or the M514A3 fuzes are used, the vertical clearance is 70 meters for all calibers. If the projectile is to be fired over marshy or wet terrain, the average height of burst will increase and, therefore, the vertical clearance shown in table 10-1 should be increased by 50 percent. If the projectile is to be fired over water or snow,

the vertical clearance shown in table 10-1 should be increased by 100 percent.

g. The XO must determine the minimum arming range before computing minimum quadrant elevation for firing a projectile with a VT fuze.

(1) He converts the minimum arming time, 2 seconds time of flight, to a minimum arming range. Because this range is directly affected by muzzle velocity, it varies for different weapons and charges. After this range has been determined, he compares it with the piece-to-crest range and uses the *greater* of the two in computing the minimum safe time and minimum quadrant elevation.

(2) To determine the minimum arming range, he enters the firing tables for the particular charge(s) and weapon system, locates the time of flight of 2 seconds (table F, column 7), and reads the range (column 1) corresponding to the minimum arming time. If the exact time of flight of 2 seconds is not listed, he uses the range corresponding to the first time of flight *greater* than 2 seconds.

(3) To determine the minimum safe time, he adds 5.5 seconds to the time of flight corresponding to the range determined above. If the value is not a whole second, he expresses it up to the next higher whole second.

h. The minimum quadrant elevation for fuze VT, when a fuze setting less than the minimum safe time is fired, is based on piece-to-crest range or minimum arming time range, *WHICHEVER IS GREATER*.

10-7. Computation of Minimum Quadrant Elevation Based on Piece-to-Crest Range

If the piece-to-crest range is greater than the minimum arming time range (fig 10-2), the XO determines and reports the minimum quadrant elevation for the crest based on the piece-to-crest range. For example-

The howitzers are 155-mm M109A1 and charge 4 green bag is to be fired. The greatest angle of site reported by chiefs of section is 16 mils, and the piece-to-crest range is 1700 meters. The XO computes the minimum

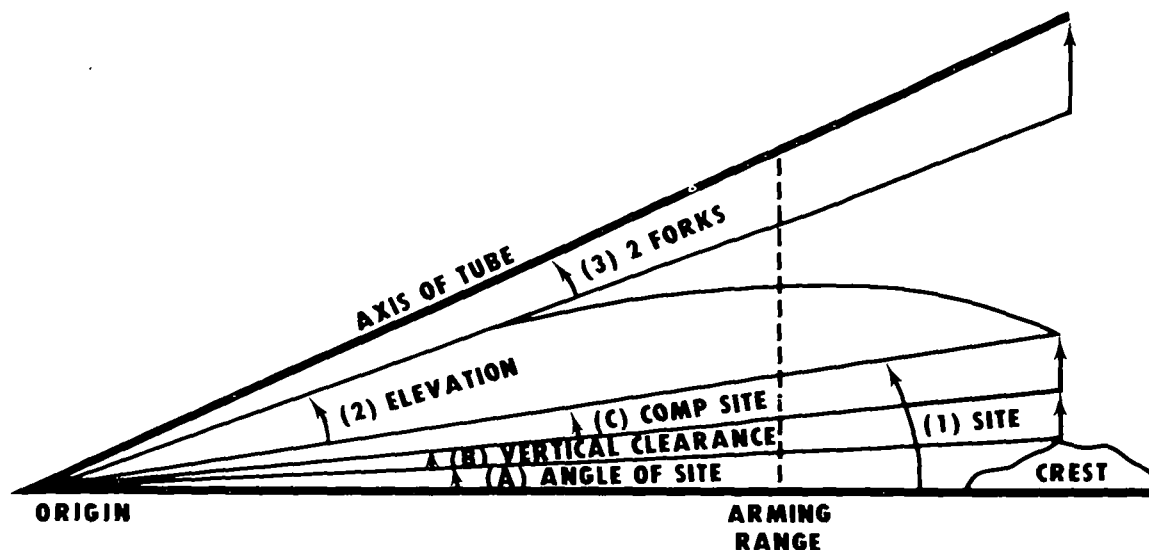


Figure 10-2. Piece-to-crest range greater than minimum arming range.

quadrant elevation as follows:

a. **ANGLE a:** Select the greatest angle of site to the crest reported by the chiefs of section -----+16 mils.

b. **ANGLE b:** Assuming the crest is occupied by friendly troops, add the value in mils of a height of 100 meters at the piece-to-crest range of 1700 meters ($100/1.7$)-----+16 mils.

c. **ANGLE c:** Add comp site for piece-to-crest range of 1700 meters to the sum of angle a and angle b. (Column 12, table G, charge 4 GB, FT 155-AM-1, range 2000 meters gives a comp site factor of 0.010.) ($16 + 60 = 76 \times 0.010 + 0.760$)-----+1 mil.

d. **ANGLE 1:** Determine site to crest (sum of angles a, b, and c). ($16 + 60 + 1 = +77$)-----+77 mils.

e. **ANGLE 2:** Determine elevation for the piece-to-crest range. ($87.7 = 88$)-----88 mils.

f. **ANGLE 3:** Add 2 forks at the piece-to-crest range.-----+2 mils.

g. **TOTAL:**-----+167 mils.

h. minimum safe time is----- $5.5 + 5.5 = 11.0$ ---11.0 seconds

i. The XO reports to the fire direction center---

MINIMUM QUADRANT ELEVATION,
FUZE VT, CHARGE 4 GREEN BAG, 167,
MINIMUM SAFE TIME 11.0 SECONDS.

With the 2-second arming time range, all the area between the arming range and the crest is made safe by the minimum quadrant elevation computed for the crest.

10-8. Computation of Minimum Quadrant Elevation Based on Minimum Arming Range

If the piece-to-crest range is less than the minimum arming range (fig 10-3) the XO uses the minimum arming range and the angle of site to the crest at arming range in computing the minimum quadrant elevation. Since the XO cannot observe the terrain beyond the crest, he must assume that the angle of site at piece-to-crest range is also applicable at arming time range. He must use it in conjunction with the other factors, which are determined at arming time range, in computing the minimum quadrant elevation. After the XO determines the minimum quadrant elevation in this manner and reports it to the FDC, the battery FDC considers the need to correct the minimum quad-

rant elevation on the basis of the range and altitude to the highest crest not visible to the XO and short of minimum arming time range. The XO computes minimum quadrant elevations on the basis of crests visible to him or minimum arming time range. Therefore, the battery FDC must examine the best available maps to determine crests not visible to the XO. Using this information the battery FDC may compute a new minimum quadrant elevation that is different from that reported by the XO; however, the new minimum quadrant elevation can never be less than the minimum quadrant elevation for fuze M557 to the visible crest. For example--

The howitzers are 155-mm M109A1's and charge 5 green bag is to be fired. The piece-to-crest range is 500 meters, the arming time range is 800 meters, and the greatest angle of site reported is +16 mils. The XO computes the following minimum quadrant elevation:

a. *ANGLE a*: Select the greatest angle of site to the crest reported.-----+16 mils

b. *ANGLE b*: Add the value in mils of a 100-meter clearance at arming time range----(100/0.8) -----+128

c. *ANGLE c*: Add comp site for arming time range to the sum of angle a and angle b (column 12, table G, charge 5 GB, FT 155-

AM-1). Since range 800 is not listed, enter at range 1,000 meters and obtain a comp site of 0.001 (16 + 128 = +144 x 0.001 = 0.144)-----+1 mil.

d. *ANGLE 1*: Determine site to crest (sum of angles a, b, and c, or 16 + 128 + 1 = 145).-----+145 mils.

e. *ANGLE 2*: Determine elevation for arming time range.-----+31 mils.

f. *ANGLE 3*: Add 2 forks at arming time range.-----+2 mils.

g. *TOTAL*:-----+178 mils.

h. Minimum safe time is-----2.2 + 5.5 = 7.7.
-----8.0 seconds.

If the fuze setting to be fired is EQUAL TO or GREATER THAN the minimum safe time, the minimum QE determined for fuzes quick and time applies. If the fuze setting to be fired is LESS THAN the minimum safe time, the minimum QE determined for ARMED VT applies.

The XO reports to the fire direction center

MINIMUM QUADRANT ELEVATION,
FUZE VT, CHARGE 5 GREEN BAG,
178, MINIMUM SAFE TIME 8.0
SECONDS.

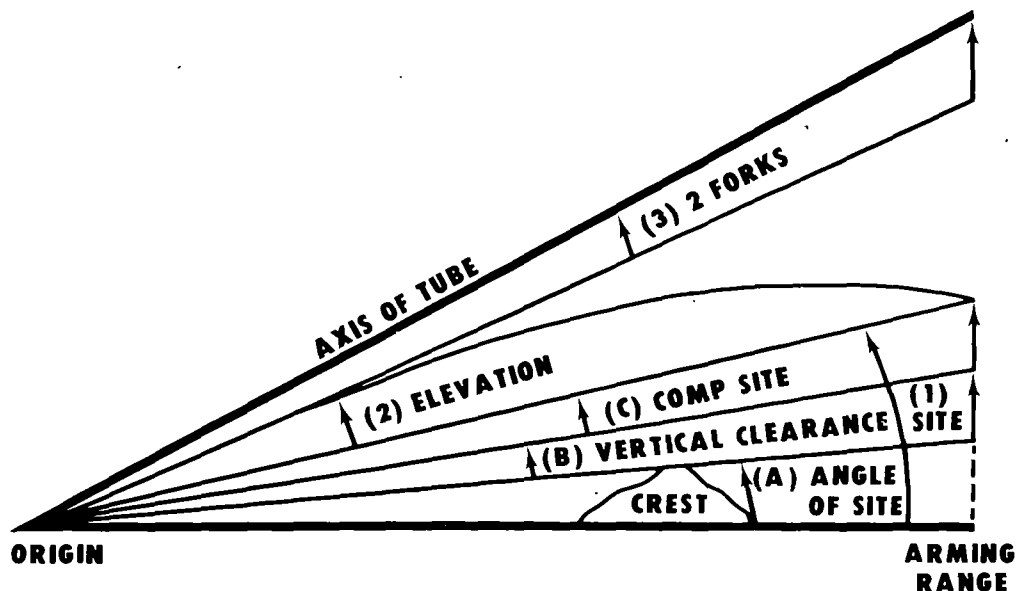


Figure 10-3. Piece-to-crest range less than minimum arming range.

Table 10-2 is a recapitulation of the steps for computing minimum quadrant elevation. It should be used as a reference by the XO

and in training individuals to compute minimum quadrant elevation.

Table 10-2. Computation of Minimum Quadrant Elevation.

ELEMENTS OF COMPUTATION	HOW TO DO THE COMPUTATION		
	Fuze PD, fuze MTSQ, or fuze VT with a fuze setting equal to or greater than minimum safe time	Fuze VT with a fuze setting less than minimum safe time	
		PC range is greater than minimum arming range.	Minimum arming range is greater than PC range.
Angle:			
1. Site	Sum of angles a, b, and c	Sum of angles a, b, and c	Sum of angles a, b, and c
a. Greatest angle of site reported	As reported	As reported	As reported
b. Vertical angle for clearance of friendly elements	5 meters divided by PC rg expressed up to a whole mil	Appropriate vertical clearance divided by PC range.	Appropriate vertical clearance divided by MAR
c. Complementary angle of site.	Multiply the CS factor at PC rg (or next greater listed range) by the sum of angles a and b	Multiply the CS factor at PC range (or next greater listed range) by the sum of angles a and b	Multiply the CS factor at MAR (or next greater listed range) by the sum of angles a and b
2. Elevation	At PC range	At PC range	At MAR
3. 2 forks	At PC range	At PC range	At MAR
All angles above are expressed to the near- est 1 mil (always express up)	The sum of angles 1, 2, and 3 equals minimum QE.		
Reported by the XO	MINIMUM QUADRANT ELEVATION, CHARGE (so-and-so), (so many mils)	MINIMUM QUADRANT ELEVATION, FUZE VT, CHARGE (so-and-so), (so many mils)	MINIMUM QUADRANT ELEVATION, FUZE VT, AT ARMING RANGE, CHARGE (so-and-so), (so many mils)
LEGEND: PC--Piece --to--crest CS--Complementary angle of site MAR--Minimum arming range			



CHAPTER 11

FIRE COMMANDS AND THEIR EXECUTION

Section I. INTRODUCTION

11-1. General

a. Fire commands give the cannon section all of the information it needs to start, conduct, and cease firing. The initial fire commands include all elements necessary for laying, loading, and firing the pieces. Subsequent fire commands include only those elements that are changed, with the exception of quadrant elevation, which is *always* announced.

b. Normally, fire commands come from the fire direction center or the BOC. The FDC receives fire missions from a forward observer, from a supported unit, or from the FDC of another headquarters and converts this mission information into fire commands. The fire commands are sent to the cannon sections by the best available means of com-

munications. Firing battery supervisors *must* insure that the FDC and cannon sections understand and use the fire commands as prescribed in this manual. It is imperative that all elements of the gunnery team (FO, FDC, and firing sections) make every effort to be responsive to the needs of the supported elements. Streamlined calls for fire, FDC procedures, and fire commands have enhanced responsiveness, but in order to achieve the desired results, each individual must understand these procedures.

c. Since numbers make up a large portion of all commands received or given in the firing battery, they must be announced in a clear, precise manner, with snap- like a *command*-and in a voice loud enough to properly understood. Numbers are pronounced as follows:

NUMBER	PRONOUNCED AS
0	Ze-ro
1	Wun
2	Too
3	Tree
4	Fow-er
5	Fife
6	Six
7	Sev-en
8	Ait
9	Nin-er
44	Fow-er fow-er
80	Ait ze-ro
100.7	Wun ze-ro ze-ro point sev-en
136	Wun tree six
500	Fife hun-dred
1478	Wun Fow-er Sev-en ait
3200	Tree too hun-dred
7000	Sev-en tou-sand
16,000	Wun six tou-sand

11-2. Sequence of Fire Commands

a. Fire commands are announced to a firing battery in the following sequence:

SEQUENCE Element	WHEN ANNOUNCED	
	Initial fire commands	Subsequent fire commands
1. Warning order	Always	Never
2. Pieces to follow/ pieces to fire/* method of fire*	Always	When applicable
3. Special instructions • Do not load • At my command • By piece at my command • High angle • Use gunner's quadrant • Azimuth • Special corrections • Primary (left right) sector • Cancel terrain corrections	When applicable	When applicable
4. Projectile*	When other than standard	When changed

*These elements may be designated as standard. Elements so designated will be announced only when something other than standard is to be fired.

SEQUENCE Element	WHEN ANNOUNCED	
	Initial fire commands	Subsequent fire commands
5. Ammunition lot *	When other than standard	When changed
6. Charge	Always	When changed
7. Fuze/fuze setting*	When other than standard	When changed
8. Direction	Always	When changed
9. Quadrant elevation	Always	Always
10. Method of fire for effect	When applicable	When changed

b. Fire commands are given to the field artillery battery in a prescribed sequence to--

(1) *Save time.* Issuing fire commands in the proper sequence allows time for the commands to be announced as rapidly as they can be understood and complied with by the personnel of the firing battery and also prevents the omission of an element of data. A prescribed sequence allows several operations to be executed simultaneously. For example, the battery is first alerted and then the data pertaining to ammunition are given followed by the deflection and quadrant elevation. This sequence allows the ammunition to be prepared for loading while the piece is being laid for direction and quadrant elevation.

(2) *Eliminate errors.* Each member of the cannon section *must* know the meaning of each element of the fire command and the sequence in which the elements are announced. Each crewman can then distinguish the numerical portion of one element from that of another element and can be on the alert for the element(s) pertaining to his duties.

c. The chief of section is not permitted to fire his weapon until he has received a complete set of commands. Explanations and examples of all elements of the fire com-

mands are presented in paragraphs 11-3 through 11-14. Some of the elements listed are used only under special circumstances and are not announced when they do not apply.

Section II. FIRE COMMANDS

11-3. Warning Order

A warning order of

FIRE MISSION

will be announced to the guns as a fire mission is received by the battery. This will alert the crews to stand by their posts and be ready to receive data.

11-4. Pieces to Follow/Pieces to Fire/Method of Fire.

a. This element designates the weapons to follow the mission and actually take part in firing.

(1) *Pieces to follow / pieces to fire alert* the battery as to which sections will fire on the target, either initially or after an adjustment has been made. This command also tells the battery which sections should follow the commands and load if appropriate.

BATTERY ADJUST

indicates that

fire will be adjusted onto the target and that the entire battery should follow the commands and fire on the target after the adjustment has been completed. The method of adjustment and rounds to be fired in effect are announced in later elements. Any weapon or combination of weapons may be announced in this element, e.g., *LEFT ADJUST, NUMBER 3 ADJUST*.

BATTERY (so many) ROUNDS

indi-

cates that a fire for effect mission (no adjustment is to be fired. Any combination of weapons may be announced here also.

(2) *Method of fire* tells the battery how many rounds are to be fired during the adjustment and in what manner. This portion may be standardized; e.g., the base piece fires one round. If a weapon other than the designated

standard is to be fired this information must be announced at this time. *EXAMPLE*

BATTERY ADJUST, NUMBER 4

ONE ROUND.

This command indi-

cates that the battery is to follow the commands and fire after the adjustment is completed and that number 4 is the adjusting piece for this particular mission. Special methods of fire used in unusual circumstances are discussed in paragraph 11-13.

11-5. Special Instructions

Special instructions are used whenever actions are required which are different from normal. They include:

a. *DO NOT LOAD* is a restrictive command that prohibits the loading and firing of the weapon(s). The section cuts the charge, sets the fuze (if applicable), and lays the weapon on the given deflection and quadrant elevation or applicable loading elevation, but *does not* load the round into the weapon. When these tasks have been completed, the chief of section reports *NUMBER (so-and-so) IS LAID*. When the round(s) is to be fired the FDC commands *CANCEL DO NOT LOAD* and gives the appropriate quadrant elevation.

b. *AT MY COMMAND (or BY PIECE AT MY COMMAND)* is a restrictive command that prohibits the battery (section) from firing until directed to do so by the FDC. The sections lay and load their weapons and the chiefs of section report to FDC,

NUMBER (so-and-so) IS READY.

The FDC will tell the section chief(s) when to fire. To return control of firing to the section

chiefs, the FDC announces--

CANCEL AT MY COMMAND (BY
PIECE AT MY COMMAND)

and gives the appropriate quadrant elevation

c. *HIGH ANGLE* is announced to alert the crew that the mission is to be fired at an angle of elevation over 800 mils. Light artillery weapons can be elevated before loading to expedite the mission; medium and heavy artillery weapons must be loaded at a loading elevation.

d. *USE GUNNER'S QUADRANT* is announced whenever FDC desires that the gunner's quadrant be used.

e. *AZIMUTH*, followed by an azimuth in mils, may be sent to the guns to alert them to a large shift in azimuth.

f. *SPECIAL CORRECTIONS* is announced any time that a separate time, deflection, and/or quadrant will be sent to one or more gun sections.

g. *PRIMARY (LEFT) (RIGHT) SECTOR* is announced when terrain gun position corrections are being used. Ordinarily, the corrections for the *primary* sector are set on the gunner's aids of all the weapons in the battery. These corrections are announced administratively. To change sectors, FDC commands *LEFT SECTOR* or *RIGHT SECTOR*. Upon termination of the mission, the howitzer sections reapply the corrections that were in effect prior to the mission.

h. *CANCEL TERRAIN CORRECTIONS* indicates that all howitzer sections are to set their gunners aid counters to zero. After completion of the mission, the terrain gun position corrections that were in effect prior to the mission will be reapplied unless the FDC indicates otherwise.

11-6. Projectile

The type of projectile that will be used to attack a target is announced in the initial commands unless it has been designated as standard. The projectile is not announced in the subsequent command unless a change

is desired.

11-7. Ammunition Lot

a. The element *ammunition lot* indicates the lot number to be fired. The lot number is announced in the initial fire commands unless a specific lot has been designated standard. The lot number is not repeated in subsequent commands unless a change is desired.

b. The lot numbers for semifixed ammunition pertain to an assembled projectile-propellant combination and, for simplicity, are coded lot X, lot Y, etc. The lot numbers for a specific projectile-propellant combination of components of separate-loading ammunition are combined. For example, in the command *LOT XY*, X indicates the projectile lot and Y indicates the propellant lot.

c. Large-quantity lots are set aside to be fired during registrations and missions when more uniform effect is important. Small-quantity lots should be used for adjust fire and other missions when uniform effect is not critical. The sections must segregate ammunition by lot number and maintain accurate records of the number of rounds on hand, by lot number.

11-8. Charge

The element *charge* indicates the amount of propellant to be used. As soon as the charge is announced, all powder increments for the round being fired are inspected and excess increments are removed.

11-9. Fuze/Fuze Setting

The type of fuze to be used is announced in the initial fire commands only when it is other than the designated standard. It is announced as a subsequent command only when a change is desired. When VT or time fuzes are fired, this element includes the fuze setting; e.g., *FUZE VT, 59.0*.

11-10. Direction

Direction is always announced as a *four-digit* deflection; e.g., *DEFLECTION 3248*.

The gunner sets the commanded deflection

on his panoramic telescope and traverses the tube until he is sighted on the proper aiming point.

11-11. Quadrant Elevation

a. Quadrant elevation is announced in initial and subsequent fire commands. *The command QUADRANT (so much) is permission for the chief of section to load and fire the round unless otherwise restricted by special instructions.*

b. In order to increase responsiveness, unit SOP's may specify that when the fuze to be fired in effect is *not* the mechanical time fuze, the nonadjusting pieces that are following the commands load the proper shell to be fired in effect *immediately upon receipt of the initial command. After the initial round is fired, each subsequent round should be loaded immediately after the preceding round is fired.* If fuze VT is to be fired in effect, the time of flight corresponding to the initial target location (rounded down) should be set on the fuzes prior to loading. The decision to use this technique is made by the battery commander, and is influenced by the state of training of the cannon section.

CAUTION: DO NOT LOAD ROUNDS INTO HOT TUBES UNLESS IT IS CERTAIN THEY WILL BE FIRED WITHIN 5 MINUTES.

11-12. Method of Fire for Effect

This element indicates the number of rounds and type of ammunition to be used in effect, when applicable. It is announced after the quadrant in adjust fire missions so as not to delay the firing of initial data. **EXAMPLE** If the initial commands include BATTERY ADJUST, the method of fire for effect might be 2 ROUNDS IN EFFECT.

11-13. Special Methods of Fire

a. **ZONE FIRE.** This method of fire is used when the standard sheaf does not adequately cover the target and more depth is required. The number of mils in the zone and the number of quadrants to be fired will be announced by FDC. For example, upon receipt

of the command

ZONE 5 MILS, 5

QUADRANTS,

each chief of sec-

tion computes the required quadrants and then fires them after the initial quadrant announced in the fire command. If in this example, announced quadrant is 310, it would be fired first; the remaining quadrants would be 320, 315, 305, and 300, fired in any order.

b. **SWEEPING FIRE.** This method of fire is similar to zone fire but provides for firing several deflections with one quadrant.

For example,

SWEEP 10 MILS, 3 DEFLECTIONS.

As in zone fire, each chief of section computes the required deflections and fires them after the initial deflection has been fired. For example, if the announced deflection is 3220, it would be fired first; the remaining deflections would be 3230 and 3210 and would be fired in any order.

c. **SWEEP AND ZONE.** This method of fire combines zone fire and sweeping fire. The chief of section will first fire the announced deflection and quadrant and then fire all combinations of the computed deflections and quadrants. For example,

SWEEP 10 MILS, 3 DEFLECTIONS,
ZONE 4 MILS, 3 QUADRANTS.

If the announced deflection is 3200 and the announced quadrant, 310, the three deflections to be fired would be 3200, 3210, and 3190 and the three quadrants to be fired would be 310, 306, and 314. Each quadrant would be fired with each deflection (total of nine rounds). Deflection 3200 and quadrant 310 would be fired first.

d. **CONTINUOUS FIRE.** When it is desired to fire continuously at a target, the

command is

CONTINUOUS FIRE.

At this command, the crews load and fire as rapidly as possible, consistent with accuracy and within the prescribed rates of fire for the

pieces. The crews continue to fire until commanded to **CHECK FIRING** or **CEASE LOADING.**

e. FIRE AT WILL. If the method of fire is for pieces to fire at will, the command is

TARGET (so-and-so), FIRE AT WILL

If a method of close defense has been prearranged, the command is simply—

FIRE AT WILL.

At this command,

the designated piece or pieces fire under the control of the chief(s) of section as the situation and target necessitate.

11-14. Examples of Fire Commands

a. Standard adjust fire mission. Elements designated as standard in this example are number 3 firing one round in adjustment shell HE, lot XY, and fuze quick.

Note. Each section should keep a minimum of six rounds of a designated standard lot of ammunition prepared and ready to fire at all times.

FIRE MISSION , BATTERY ADJUST, CHARGE 6, DEFLECTION 2938, QUADRANT 200, 2 ROUNDS IN EFFECT.

(1) Number 3 fires one round of shell HE, fuze quick, at the announced deflection and quadrant, lot XY and reloads.

(2) The first subsequent fire commands in this example are--

DEFLECTION 2978, QUADRANT 218.

Number 3 fires the new deflection and quadrant and reloads.

(3) The second subsequent fire com-

mands in this example are--

BATTERY 2 ROUNDS, DEFLECTION 2950, QUADRANT 210.

The entire battery fires two rounds at the announced quadrant and deflection. *END OF MISSION* is commanded as appropriate.

b Nonstandard adjust fire mission. Elements designated as standard in this example are number 3 one round, shell HE, ammunition lot, and fuze quick.

FIRE MISSION, BATTERY ADJUST, NUMBER 4.1 ROUND, CHARGE 4, DEFLECTION 3024, QUADRANT 447, 2 ROUNDS ICM IN EFFECT.

(1) Number 4 is announced as the adjusting weapon and fires charge 4 at the announced deflection and quadrant. The remainder of the battery prepares two rounds of ICM and follows the fire mission. The adjustment continues as in the first example. When fire for effect is entered, the commands are--

BATTERY 2 ROUNDS, SHELL ICM, FUZE TIME, 24.2, DEFLECTION 3008, QUADRANT 442.

(2) The entire battery fires two rounds of shell ICM at the announced time, deflection,

and quadrant.

END OF MISSION

is commanded as appropriate.

c. Standard fire-for-effect mission. Elements designated as standard in this example are number 3 one round, shell HE, fuze quick, ammunition lot, and fuze.

FIRE MISSION, BATTERY 2 ROUNDS, CHARGE 4, DEFLECTION 3377, QUADRANT 487.

Each weapon in the battery fires two rounds

of the standard shell and fuze at the announced deflection and quadrant.

d. Nonstandard fire-for-effect mission. In this example, no standard elements are used.

**FIRE MISSION, NUMBER 2, 3, 4,
AND 5, 3 ROUNDS, AT MY COM-
MAND, SHELL WP, LOT TZ,
CHARGE 7, FUZE QUICK, DE-
FLECTION 2870, QUADRANT 320.**

Numbers 2, 3, 4, and 5 each fire three rounds of the announced shell and lot, charge 7, and fuze quick at the announced deflection and quadrant. Since the special instruction **AT MY COMMAND** was announced, the section chiefs report *READY* and wait to fire until given permission to fire by FDC.

11-15. Check Firing/Cease Loading

a. The command

CHECK FIRING

is normally given by the FDC but may be given by anyone present. On this command, regardless of its source, firing will cease immediately. The signal for *CHECK FIRING* is to raise the hand in front of the forehead, palm to the front, and swing the hand and forearm up and down in front of the face. Another signal for *CHECK FIRING* is one long blast on a whistle. Firing is resumed at the announcement of *CANCEL CHECK FIRING* and the quadrant elevation.

b. The command

CEASE LOADING

is similar to *CHECK FIRING*. Upon receipt of this command, the cannoneers may fire the weapons that are already loaded, but no additional rounds may be chambered. Firing is resumed at the announcement of

CANCEL CEASE LOADING

and

the quadrant elevation.

11-16. End of Mission

The command

END OF MISSION

means that the fire mission has been completed. All corrections applied to the fire control equipment for that mission are to be removed. Primary terrain gun position corrections are to remain on the gunners aid counters unless commanded otherwise by the fire direction center. If a priority target has been assigned, each gun will lay on the firing data for its assigned target.

Note. The assigned targets may not always be located in the primary sector so the applicable position corrections (primary, left, right) must be applied to the gunners aid prior to setting off and laying on the assigned target data.

11-17. Repetition of Commands by Chief of Section

a. By voice communications. Chiefs of section repeat the commands **FIRE**, **CHECK FIRING**, and **CEASE LOADING**. Any other fire commands are repeated only when requested or when they obviously have not been heard or understood. The request for repetition is stated as a question; e.g., **DEFLECTION NUMBER (so-and-so)?**

b. By intrabattery communications. When radio or wire communications are used between the FDC and the individual gun sections, the readback of elements of the fire commands is governed by unit SOP. One piece should be designated to read back all fire commands. If the howitzer loudspeakers are not working, the person designated by the chief of section to operate the radio or telephone must announce each element of the fire command to the section.

c. By FDC. The repetition of commands by the FDC is always preceded by **THE COMMAND WAS**; e.g., **THE COMMAND WAS DEFLECTION 2768**.

11-18. Preplanned Targets

a. At times the battery will be assigned preplanned targets, which must be fired quickly. One of these will be designated by the FDC as the priority target, and each weapon will be laid on its assigned priority target when not actively engaged in a mission. Appropriate ammunition will be

kept on hand and personnel at the piece will begin firing the weapon as soon as a command is received.

b. One common type of priority target is the final protective fire (FPF). To order the

FPF to be fired, the command

FIRE

THE FPF or a prearranged signal is given.

c. In offensive operations, suppressive fires are frequently delivered by the artillery battery. Some of these may be planned fires; if so, each section maintains firing data on these targets as directed by the FDC. These targets are recorded at the section as follows:

platoon would re-lay and fire the data for target 54.

11-19. Reports

The section chief reports to the FDC all actions that affect the firing of his weapon in support of the battery mission. In the conduct of firing the following *specific* reports are made:

a. *SHOT NUMBER (so-and-so)* after each round of a fire mission has been fired. If a round or fuze *other* than the one announced by the FDC is fired, it *must* be reported to the FDC.

b. *ROUNDS COMPLETE NUMBER (so-and-so)* when the final round of fire for effect

PRIORITY TARGETS									
TGT NO.	SP INST	RDS	SH	LOT	CHG	FZ	TI	DF	QE
43	—	2	HE	XY	6	Q	—	3210	402
54	—	2	HE	XY	6	VT	29.0	3190	418
57	—	4	SMK	TY	6	TI	31.0	3182	432

In this case the sections in the platoon would lay on target 43. The command from FDC

to fire would be **(so-and-so) SUPPRESS,**

followed by the target number; e.g.,

RIGHT SUPPRESS, 43. If targets

54 or 57, are to be fired, the command would be

RIGHT SUPPRESS 54, which means the

(other than one round) has been fired.

c. *MISFIRE NUMBER (so-and-so)* when there has been a misfire. The chief of section reports **NUMBER (so-and-so) IS READY** when the piece is ready to fire.

d. *NUMBER (so-and-so) IS OUT (reason)* when a piece has been called out of action.

e. *Number of rounds expended*, by type and lot number (when required).

f. *Errors.* Chiefs of section must tell the FDC if any round has been fired with im-

proper data. The executive officer has the error(s) corrected and reports to the battal-

ion FDC, e.g.,

NUMBER 2 FIRED 20

MILS RIGHT.

11-20. Correcting Fire Commands

a. If an incorrect command has been given but the command *QUADRANT* has *not* been announced, the FDC commands—

CORRECTION

and then gives the

correct command and all subsequent elements.

b. If *QUADRANT* has been announced, the FDC commands

CHECK FIRING.

Then

CANCEL CHECK FIRING,

is

announced followed by the proper element and all subsequent elements.

11-21. Miscellaneous Commands

a. *Special corrections.* In addition to the special corrections indicated in paragraph 11-5, other special corrections may be announced administratively; e.g., position corrections or instructions to open or close the sheaf for a particular mission. The commands are—

SPECIAL CORRECTION, NUMBER (so-and-so) LEFT 7.

This command may

be given administratively, apart from fire commands, or may be announced in the SPECIAL INSTRUCTIONS element of fire commands.

SPECIAL CORRECTIONS, ON BASE PIECE (or NUMBER so-and-so), OPEN (CLOSE) (so many).

In this example each piece other than the

base piece applies a correction to the announced deflection by placing the correction on the gunner's aid. Each gunner determines his correction by multiplying the correction announced in the command by the number of pieces his piece is removed from the one on which the sheaf is to be opened or closed.

For example, the command

ON

is given.

NUMBER 3 CLOSE 4

Number 3 fires the announced deflection. Number 1 applies left 8; number 2, left 4; number 5, right 4; and number 6, right 8. These corrections are applied to any position corrections already on the gunners aid, and remain in effect until the command END OF MISSION is given.

b. *Referring to an aiming point.* To have a weapon or the battery refer to a particular aiming point, the XO or chief of firing battery commands—

AIMING POINT (whatever) REFER.

If he desires to know the referred deflection, he also commands—

REPORT REFERRED DEFLECTION.

If it is desired that the indicated weapon(s) make this aiming point its (their) primary aiming point, then after referring the piece(s) to the aiming point as in the example above, the command—

DEFLECTION (base deflection) REFER

is given. For example, the commands—

NUMBER 4, AIMING POINT CHURCH STEEPLE REFER.

DEFLECTION 3200 REFER are given.

The gunner then sets the announced deflection on the reset counter or slipping azimuth scale and uses the new aiming point as his primary aiming point.



CHAPTER 12

SPECIAL SITUATIONS

Section I. ASSAULT FIRE

12-1. General

a. Assault fire is a special technique of indirect fire. Fire is conducted at a relatively short range to obtain pinpoint accuracy against a stationary target (e.g., bunkers or caves). The gun-target range is sufficiently short to make possible successive hits on the same portions of the target. Only one piece is used on a mission, and the BOC is located at the cannon position. Thorough planning, reconnaissance, and coordination must be completed before the position is occupied. Since artillery is at a premium, this technique should be considered *only after* maneuver force weapons, such as tanks, have failed or because terrain prohibits their use.

b. Any artillery cannon can be used for assault fire; however, any caliber smaller than 155-mm is considered uneconomical. The most efficient weapons, in order of preference, are the 8-inch howitzer, the 155-mm howitzer, and the 175-mm gun. Self-propelled weapons are best suited for this task because of their maneuverability and ease and speed of emplacement and displacement. When the maximum charge is used, maximum effective assault fire ranges are 3000 meters for the 8-inch howitzer and 2500 meters for the 155-mm howitzer and the 175-mm gun.

12-2. Assault Fire Procedures

a. Normal fire direction procedures and fire commands are utilized; however, in order that the small deflection changes that are necessary in assault fire can be made, a special technique of laying is employed at the piece.

b. Deflection changes are made to the nearest mil until a 1-mil deflection bracket has been obtained; further changes are made to the nearest one-fourth mil. *One-fourth mil can be set on weapons equipped with the M100-series sights. For weapons with M12-series sights, a deflection board (which must*

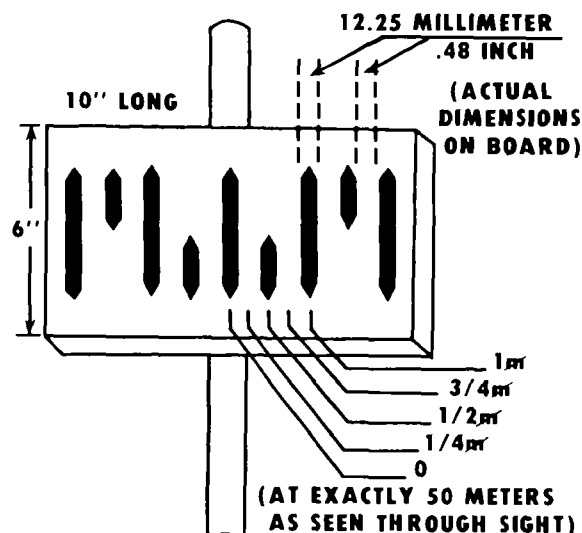


Figure 12-1. Deflection board.

be locally fabricated) attached to an aiming point (fig 12-1) enables the gunner to make deflection changes to one-fourth mil. The black and white bands (lines) are one-fourth mil in width when viewed through the sight of the piece at a distance of exactly 50 meters.

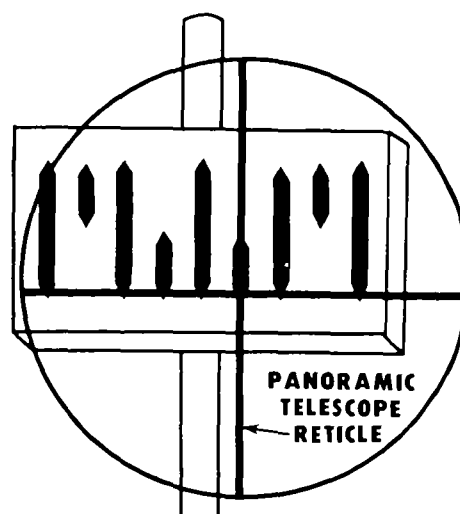


Figure 12-2. Gunner's sight picture.

One board per howitzer is required. The gunner lays on the desired portion of the board by centering the vertical crosshair of the sight on a black (white) band on the board. To move one-fourth mil, he moves the line of sight by traversing the piece in the proper direction so that the adjacent white

(black) band is covered; to move one-half mil he moves the vertical crosshair until the second band is covered, etc. Figure 12-2 shows the sight picture when deflection is moved to the right by one-half mil. For changes in elevation to the nearest 0.1 mil, the gunner's quadrant is used.

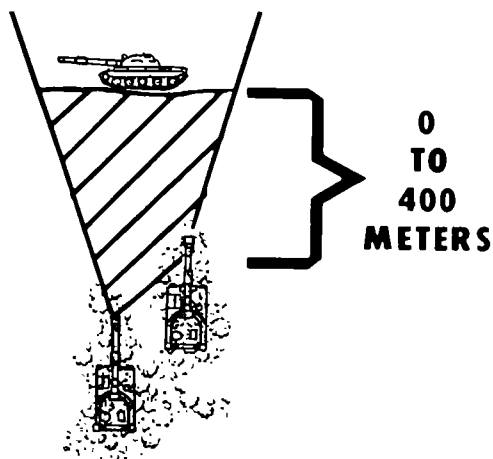
Section II. DIRECT FIRE

12-3. General

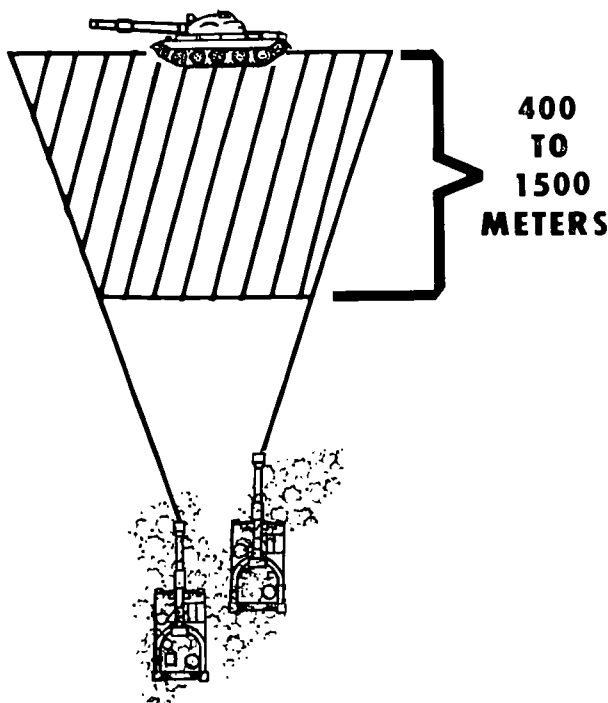
a. Direct fire is a special technique that demands a high standard of training. The section must operate as an independent unit. Enemy targets taken under fire by direct fire procedures are usually those capable of returning direct fire; therefore, speed and accuracy are of the utmost importance. The commander **MUST** bear in mind that direct fire is used as a **LAST RESORT ONLY**, after the location of the battery has been detected by an enemy force *and* that force has launched an attack against it.

b. The trajectory of the weapon involved, the types of target, and the types of ammunition and fuzes to be employed against various targets must be considered by the XO. The maximum charge should always be used for direct fire. Here are some considerations for trajectory, types of targets, and ammunition.

(1) Trajectory. Trajectory characteristics change with the type of ammunition and the charge fired. The following information is based on use of charge 7.

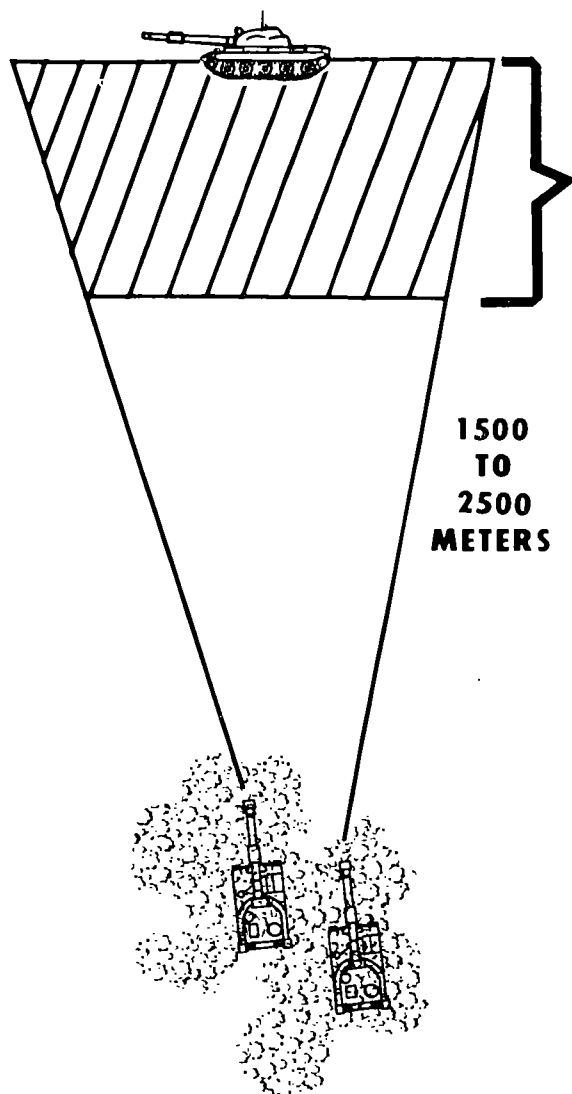


(a) 0-400 METERS. Within this range the trajectory will be flat enough to prevent an 8-foot tank from passing safely under it. The optimum range at which to engage a target with direct fire is 400 meters. Terrain allowing, targets should be engaged at as close to 400 meters as possible.



(b) 400-1,500 METERS. In this zone the trajectory is flat enough to allow direct estimation of range without actual bracketing of the target. Assuming little dispersion, if you obtain a hit at the bottom of an 8-foot tank when firing at 1500 meters, a 100-meter increase in range will give you a round that will just brush the top of the tank. If adjusting within this zone, range changes of more than 100 meters should *not* be made. Usually,

range changes in 50-meter increments will give the best results. The upper limit (1500 meters) of this zone is considered the maximum range at which a target should be engaged except in unusual situations. Within this zone, a well-trained crew should require no more than two shots to obtain a hit.



(c) 1500-2500 METERS. Hits are only reasonably possible in this zone, and the bracket method of adjusting will probably be required to obtain a hit. Do not engage a target at these ranges unless absolutely necessary.

(d) OVER 2500 METERS. In this zone direct laying is not advised, as a *hit on a moving target, even with accurate bracket-*

ing and range estimation, is very unlikely.

(2) Types of targets. The most likely direct fire targets are vehicles, tanks, and/or dismounted personnel that are threatening the battery. Enemy personnel, alone or with tanks, will not usually present themselves as clearly defined targets. In this case, fire should be delivered in the AREA containing the attackers rather than on the individuals. Tanks usually attack in groups and may be accompanied by infantry. Priority within a given sector of direct fire should be given to--

(a) Tanks at short ranges threatening to overrun the position.

(b) Hull-down stationary tanks covering the advance of other tanks.

(c) The commander's tank, if identified.

(d) Tank(s) nearest to cover.

(3) Ammunition and fuzes.

(a) Ammunition. Against armor and vehicles--

1. Antitank ammunition, high-explosive, plastic-tracer (HEP-T), available for 105-mm only, is best.

2. The high-explosive shell is effective against armor and vehicles, but you must attempt to hit a vulnerable portion of a tank (e.g., side view, hit the track or road wheels; front view, hit between the carriage and the turret).

3. Smoke shells (HC or WP) can be used very effectively to obstruct the vision of tank gunners.

4. The white phosphorus shell is excellent for setting immobilized tanks and vehicles on fire.

5. The Beehive antipersonnel round, if available, is very effective.

6. Improved conventional munitions (ICM) can be effectively employed close in by use of indirect fire techniques.

7. The high-explosive shell with VT or mechanical time fuze is lethal against unprotected troops and is effective for separating infantry from tanks.

(b) Fuzes

1. When the HE round is fired against tanks or vehicles, the impact fuze should be used in the superquick mode.

2. Against personnel, the impact fuze in the delay mode may cause an effective ricochet effect. When the delay mode is utilized, the point of impact must be adjusted 10 to 30 meters in front of the target. If the ground is such that less than half the shells can be expected to ricochet, the superquick mode should be used.

3. Proximity, variable time, and mechanical time fuzes can be used with the HE shell against personnel; however, the mechanical time fuze will generally give erratic results.

12-4. Sighting

There are three primary methods of sighting utilized in direct fire:

a. Two-man, two-sight. This method is *best* for all weapons *except* the 155-mm howitzer M114A1. The gunner establishes lead with the panoramic telescope and the assistant gunner establishes elevation with the direct fire telescope. This is the fastest and most accurate method of sighting and permits the assistant gunner to check the direction of lead. The reticle in the direct fire telescope **MUST** be level. A canted reticle in the direct fire telescope will prevent satisfactory direct fire on moving targets because an unacceptable range error is introduced when lead is changed.

b. Two-man, one-sight. This method is *best* for the M114A1. The gunner establishes lead with the panoramic telescope and the assistant gunner sets elevation on the elevation quadrant at the command of the chief of section. This method is *not* effective when the target is moving on other than flat terrain.

c. One-man, one-sight. This method is *least desirable* and should *not* be used unless absolutely necessary. The gunner lays for lead and elevation with the reticle of the panoramic telescope. This method should *not* be used if the target is moving on a steep slope.

12-5. Laying

There are two primary methods of laying:

a. Reticle laying with deflection zero. This method is *best for the M12-series sights*. The gunner maintains lead by placing the vertical hairline the proper number of mils ahead of the point of aim on the target (fig 12-3).

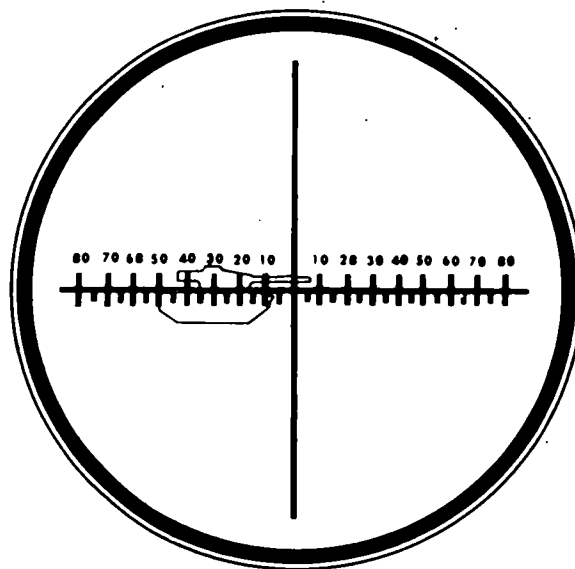


Figure 12-3. Gunner's sight picture, reticle laying, lead right 10 mils.

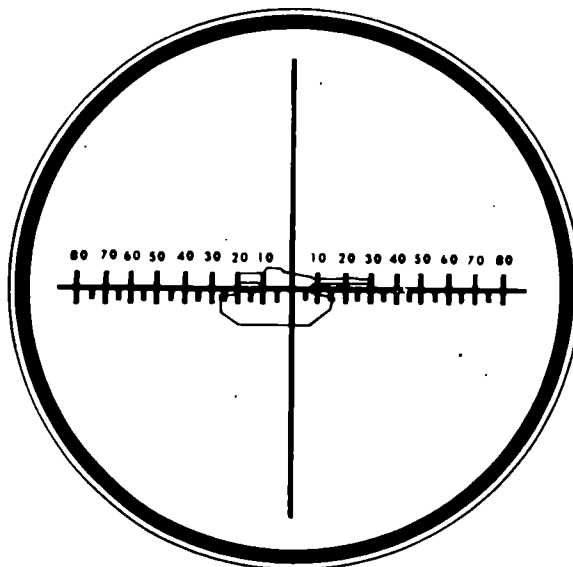


Figure 12-4. Gunner's sight picture, central laying.

b. Central laying. This method is *best for M100-series sights*. The gunner sets the lead in mils on the azimuth micrometer scale of the panoramic telescope and maintains the vertical hairline of the reticle on the center of the target (fig 12-4). A modification on the knob of the M100-series panoramic telescope, called click sights, permits the gunner to set off lead in 5-mil increments, by sound or feel, without removing his eye from the sight.

12-6. Commands

a. Commands for direct fire are normally given by the howitzer section chief. The commands include--

(1) A warning order-- **TARGET (so-and-so).**

(2) General direction to the target-- **LEFT FRONT.**

(3) Lead in mils (how to determine lead is

explained in the user's manual)--

LEFT 5.

LEAD.

(4) Range to the target (or quadrant for the M114A1)-- **RANGE 500.**

(5) Method of fire-- **FIRE AT WILL.**

b. The shell, fuze, and charge to be fired should be standardized in order to save time. If a shell/fuze combination other than the

standard is desired, the command **SHELL (so-and-so) FUZE (so-and-so),** with time if applicable, is given after the direction to target.

Section III. SPLIT BATTERY OPERATIONS

12-7. General

Tactical considerations may dictate that a cannon battery be split into separate firing elements. Survivability will probably preclude radio transmission of fire commands and require that each split element have its own fire direction capability. A battery FDC that has the normal complement of personnel and equipment can be split for operations of short duration. The battery operations center (BOC) will normally accompany the split element.

12-8. Splits of Limited Duration

a. *Personnel.* Split operations usually require firing of all types of missions, so cross-training is essential. Suggested personnel for a reduced-crew FDC are--

(1) *Fire Direction Officer.* The battery commander, executive officer, or assistant executive officer should be prepared to perform this function.

(2) *Computer.* Each reduced-crew FDC should have an individual capable of deter-

mining chart data and computing firing data. In a FADAC-equipped FDC the FADAC operator (HCO) should be cross-trained to perform manual firing computations.

(3) *Radiotelephone operator.* In addition to normal duties, this individual should know how to determine chart data and compute site.

b. *Equipment.*

(1) Logistical and mobility considerations usually dictate that FADAC remain with the main element and that manual computations be performed in the BOC.

(2) Persons acting as computers should be trained in the use of the GFT fan. This modified RDP allows computation of both chart and firing data by one person and facilitates a one-man manual backup to the FADAC.

(3) Additional radios may be necessary for the split element to perform its mission.

12-9. Sustained Split FDC Operations

Experience has shown that an FDC that is split for long periods of time and operated on a 24-hour basis must be augmented in both personnel and equipment. Further augmentation may be required on a modern battlefield, where frequent moves and position

hardening are commonplace. Failure to augment under such circumstances may result in frequent errors and reduced responsiveness. Cross-training of other battery personnel in fire direction procedures is necessary. Specific makeup of the FDC depends on proficiency of personnel and length and intensity of the split operations.

Section IV. EMERGENCY BORESIGHTING

12-10. General

a. Boresighting is the only means a gunner has of insuring that the optical axes of his sights are parallel to the tube of the weapon. The weapon should be boresighted--

(1) Any time the sight has been subjected to any shock other than firing.

(2) Prior to firing in a new firing position.

(3) Any time the howitzer fires inaccurately for no apparent reason.

b. The primary methods of boresighting, in order of preference, are--

(1) Boresight alinement device.

(2) Distant aiming point.

(3) Testing target.

c. All of these methods are discussed in detail in the applicable user's manual or weapons field manual.

12-11. Collimator Method

The collimator may be used to boresight weapons when methods outlined in paragraph 12-10 cannot be used.

a. Prepare the weapon for boresighting in the same manner as for the DAP method.

b. Place the M1 infinity collimator about 10 meters in front of the tube.

c. Sight through the tube and aline the 0 of the collimator with the vertical muzzle bore-sight string.

d. Sight on the collimator with the panoramic telescope, matching the numbers on the sight with the numbers on the collimator. The

reading should be 3200. If it is not, adjust the reading.

12-12. Standard Angle Method

a. For the M101A1, M114A1, M110, or M107 howitzer the standard angle must be established during the conduct of a fire control alinement test. The procedures are outlined in the applicable user's manual or FM. To boresight by the standard angle method (fig 12-5)--

(1) Establish the recoiling parts in the same relationship to the nonrecoiling parts as they were when the standard angle was established.

(2) Place a pin in the left witness mark on the muzzle.

(3) Install the parallax shield.

(4) Set the standard deflection angle on the telescope.

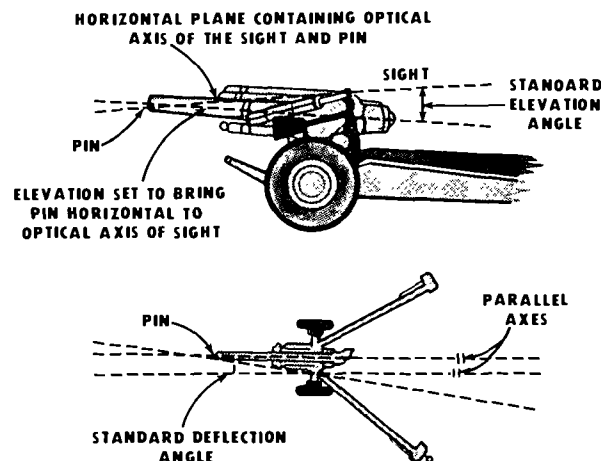


Figure 12-5. Standard angles.

(5) Using a tested gunner's quadrant, set the standard elevation angle.

(6) Match all scribed lines.

(7) If the weapon is out of boresight, do not disturb the bubbles; adjust the vertical

hairline onto the junction of the pin and the muzzle.

b. As soon as possible, the boresight should be verified by a more accurate means.



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CHAPTER 13

COMMUNICATIONS

13-1. Introduction

a. In our ability to communicate on the modern battlefield, we face two obstacles--frequent moves and the enemy's sophisticated electronic warfare capability. Communications systems must be oriented toward overcoming these obstacles.

b. The cannon battery has available to it two major communications systems--the *radio system* and the *wire system*. Neither one is the primary system. Each has different capabilities, vulnerabilities, and limitations and each must be employed to complement the other.

c. Frequent moves will almost certainly increase the battery's reliance on radio communications. Unfortunately, the enemy is equipped and trained to employ electronic warfare effectively. If the enemy jams a battery's radio communications, he has probably reduced the effectiveness of that battery.

d. Another aspect of the enemy's electronic warfare capability is his use of radio direction-finding equipment, which indicates the position of transmitting radios. A long-winded radio operator may well find enemy artillery pouring in on his position within minutes. The most effective way to combat this threat is the use of **STRICT COMMUNICATIONS DISCIPLINE**. Units must be able to march under absolute radio listening silence. Fire nets must remain unused until needed for support of the maneuver element. The commander can counteract the enemy's electronic warfare capability by enforcing wise, disciplined utilization of all the communications assets available to him. This cannot be accomplished without a thorough training program--not just for the communications section but for all the people in the battery who use communications equipment. Some tips for the conduct of this training are in the latter part of this chapter.

13-2. The Radio System

a. The cannon battery operates radio stations in the command/fire (CF) net or the

alternate CF net as directed by battalion headquarters. Additional requirements may be as follows:

(1) The battery may operate in one of three fire direction (FD) nets (F1, F2, and F3) in the direct support battalion. These nets are normally assigned one per cannon battery. Principles of operating the FD nets are--

(a) Expose FD nets on a *demand* basis by the forward observer or as directed by the battalion FDC.

(b) *Never* use the FD net for low-level administrative traffic.

(2) The battery may monitor the maneuver company/team command net when it is in the dedicated battery role or the maneuver battalion command net when performing a DS mission.

(3) General support, general support-reinforcing, and reinforcing units normally operate in only one FD net, but it is conceivable that a reinforcing or GSR unit would be given the task of dedicating one of its batteries to a maneuver unit. That battery's communications requirements would be the same as those of the direct support unit in the dedicated role.

b. The wire communications requirements for the FDC and BOC are discussed in paragraph 13-5. The required battery radio system is shown in figure 13-1. For maximum flexibility, all cannon units should try to distribute their radios in this manner. The BOC

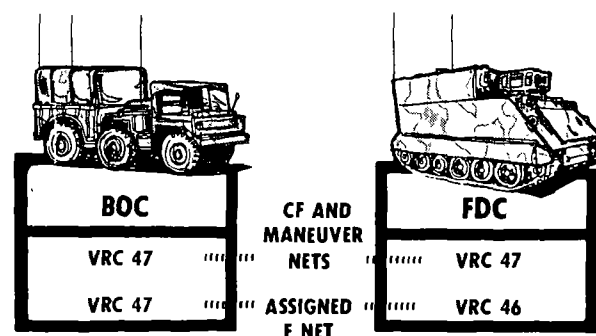


Figure 13-1. Cannon battery radio communications.

should have one VRC-47 installed and the battery commander's VRC-47 should be remoted into it when his vehicle is in the area.

c. In those units that do not have sufficient radios to provide three nets in both locations, the following setup will allow the FDC adequate communications:

(1) The two VRC-46 radios should be located in the FDC.

(2) The VRC-47 should be located in the BOC and remoted into the FDC for monitoring the maneuver net.

Table 13-1. Radio Operator Performance Objectives.

1. Install a radio and begin operation.
2. Troubleshoot communications equipment when failures occur.
3. Erect the RC-292 antenna, assemble it properly for a particular frequency and disassemble it (BOC and FDC personnel only).
4. Perform operator-level maintenance on a radio.
5. Remote a radio set (FDC and BOC personnel only).
6. Know the structure of the unit's radio net.
7. Use the CEOI, unit SOP, and authorized codes.
8. Use correct radio transmission procedures.
9. Identify enemy jamming and imitative communications actions and take proper countermeasures.
10. Set up, install, and operate electronic speech security equipment, to include use of the code changer key.

13-3. Communications Discipline

Communications discipline must be an item of command concern. It should be integrated into all training and emphasized over

and over. The following are some ways to enhance communications discipline:

a. Thorough SOP's and use of both the operating and brevity codes contained in the CEOI's can substantially reduce the number and length of required radio transmissions.

b. Runners should be utilized whenever feasible.

c. Lengthy radio transmissions must be forbidden.

d. Operators must resist the temptation to make frequent radio checks.

e. Use low power settings whenever possible.

f. Reports and statistical updates should be closely scrutinized and only those absolutely necessary transmitted by radio.

g. The battery should habitually displace under radio listening silence. This requires command emphasis and training. It will become even more difficult when the cannon sections are provided radios.

13-4. Tips For Training Radio Operators

The battery communications system is only as good as its operators. The following guidelines are offered as an approach to developing an effective training program for radio operators. A list of specific performance objectives for radio operators is in table 13-1.

a. Identify the principal radio operators and backup operators. This group will include ANYONE, regardless of MOS or grade, who will normally operate a radio set.

b. Radio operators should be trained weekly, as a minimum. This drill should exercise as many of the skills indicated in table 13-1 as possible. Much realism can be integrated into the training if actual battery radio transmissions on field exercises, CPX's, etc. are recorded and then used in developing a drill format.

c. The drill sessions should be recorded, if possible. This allows the operator to hear himself and identify his own weaknesses.

d. Putting up the RC-292 antenna and trimming it properly takes a lot of practice. The FDC and BOC personnel should be drilled regularly in this task and should strive for a time of 5 minutes or less.

e. Training should also include taking the antenna down after it has been erected to change frequencies.

f. Commanders should insure that the antenna is habitually erected and that personnel are as proficient at this task during darkness as they are during daylight.

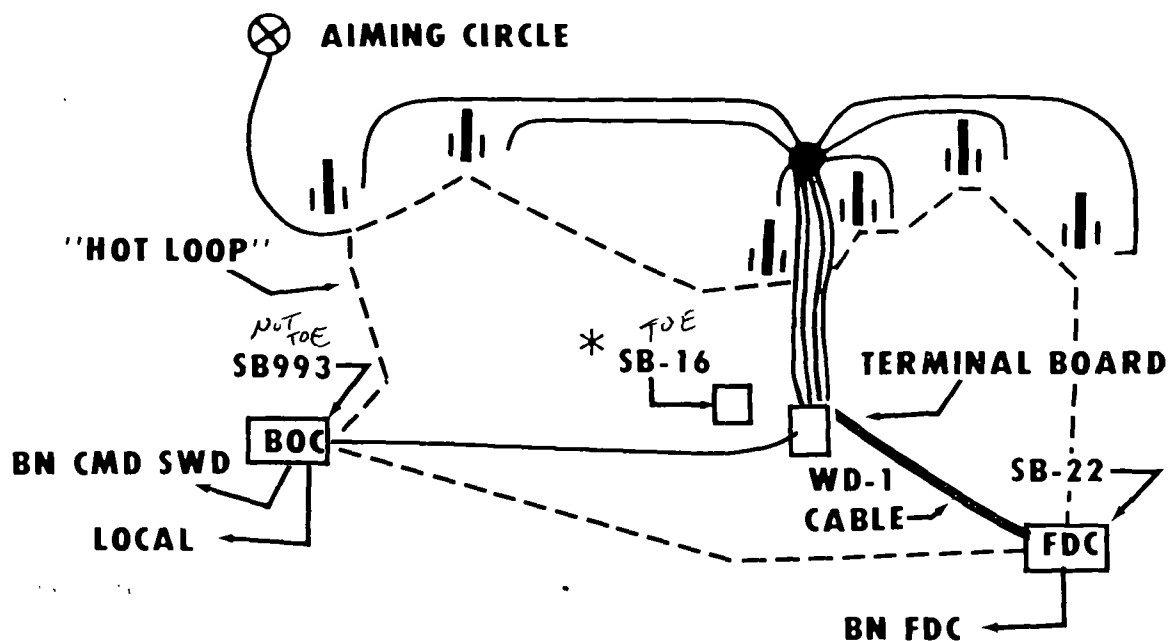
13-5. The Battery Wire System

a. Ordinarily, all the wire teams will be consolidated under the control of the battalion communications platoon. This system allows a vehicle for each wire team and speeds up the establishment of wire communications between the battery and the battalion headquarters. It is the responsi-

bility of the battalion wire team, then, to furnish both command and fire direction circuits to each battery.

b. Cannon battery personnel within those sections that use wire communications (FDC, BOC, howitzers, etc.) must be trained to establish, protect, and repair the intra-battery wire communications system. A suggested system is shown in figure 13-2.

c. In this system, the SB-16 (MX155) is set up initially (preferably by the reconnaissance party) to lay the battery. Each cannon lays a line to it. Wire lines from the DR-8's at the sections are routed around a stake in front of the line of metal to insure that they are not torn up by local traffic in the area. The XO plugs a line from the aiming circle into the DR-8 of the nearest cannon. Utilizing wire, he then lays the battery. This allows the drivers to observe the proper engine shut-down procedures without disturbing the laying process.



* **NOTE - SB-16 IS USED TO LAY THE BATTERY INITIALLY**

Figure 13-2. Intrabattery communications.

d. The terminal board (fig 13-3) is set up next to the SB-16 by the XO's driver or someone in the FDC. The wire lines that are plugged into the SB-16 (which *must* be tagged or color coded) for laying the battery are then easily transferred to the terminal board.

e. The FDC has a preassembled cable of seven pairs of WD-1 attached to the TM-184 portion of the terminal board. Ordinarily these wires can remain hooked up during movement. The other end of the cable is attached to the FDC SB-22 switchboard.

f. The BOC also lays one line to the terminal board. All lines should be buried or overheaded as soon as possible for protection. Once all wire lines have been transferred to the terminal board, the SB-16 is taken up to be used again by the reconnaissance party.

g. The terminal board, which must be fabricated locally by using units, is essential for efficient simultaneous handling of multiple fire missions. It consists of a TM-184 circuit board (① fig 13-3) mounted on a steel stake (②, fig 13-3). The steel stake mount should be sharpened to a point at the bottom so that it can be driven into the ground. Seven U-17 jacks (③, fig 13-3) are screwed into the back of the TM-184 and wired to their respec-

tive posts (④, fig 13-3). This system allows maximum selectivity for the FD computer.

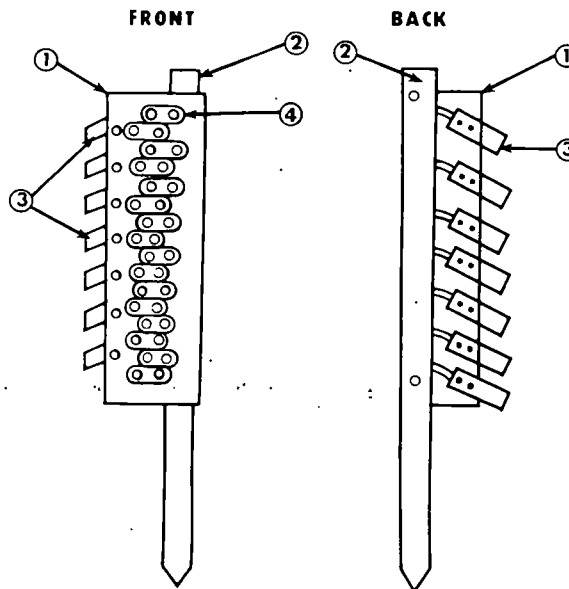
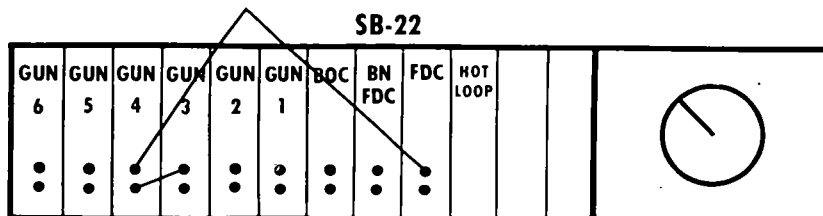


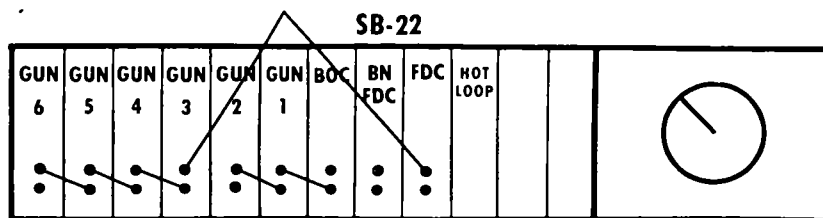
Figure 13-3. Terminal board.

h. To give the BOC a switching capability, the SB-993 is used. Administrative lines, such as those to battalion headquarters and outposts, should be routed into the BOC. The following are examples of the flexibility this system allows.

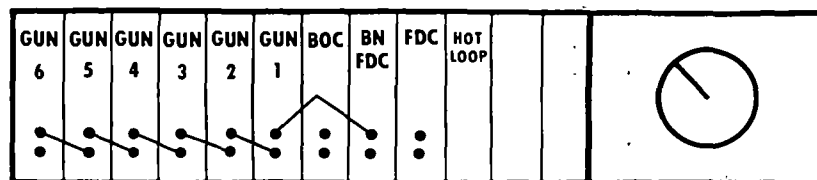
EXAMPLE 1--FDC firing center platoon only.



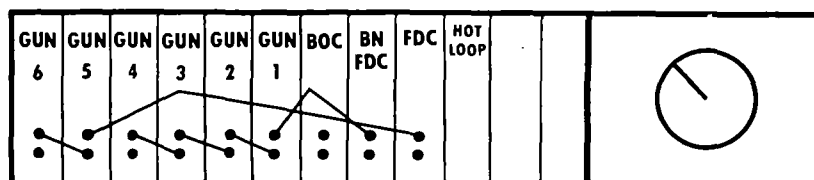
EXAMPLE 2--BOC firing right platoon, FDC firing center and left platoons.



EXAMPLE 3-In this example, the battalion FDC is controlling the fires of the battery. A suppressive fire mission is received at the battery from one of its forward observers;



so to fire the left platoon, battery FDC seizes control like this--



i. As soon as time permits, a hot loop should be laid for a backup as shown in figure 13-2, but it is not hooked up to the cannons until it is needed. The FDC and BOC hook up the hot loop to their switchboards. If, during a mission, one cannon loses its communications, its telephone should be immediately disconnected from the line to the terminal board and hooked up to the hot loop. The FDC is called and uses the hot loop circuit to communicate with that cannon until the line to the terminal board is repaired. If the seven-pair cable is broken, everyone utilizes the hot loop until repairs are made. (If you use WD-1 to make that cable, you will find it harder to damage and easier to repair than commercial types of cable.)

13-6. Priorities

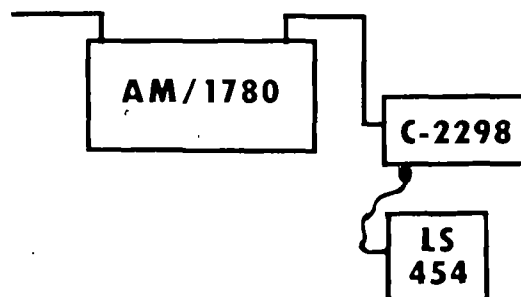
Wire lines should be laid according to the following priorities:

- All cannons plug into the SB-16.
- Wire lines are transferred to the terminal board. The BOC and FDC hook up into the terminal board.
- Outpost lines are laid by outpost personnel.
- Hot loop backup is laid.
- Administrative lines are installed.

13-7. Enhancing Wire Communications

a. One of the serious drawbacks of using the field telephone is that only the telephone operator hears the conversation. He must then relay the fire commands, and there is no check on what he says. One way of alleviating this problem and freeing one man from monitoring a telephone is to use amplifiers and speakers at the cannons and in FDC.

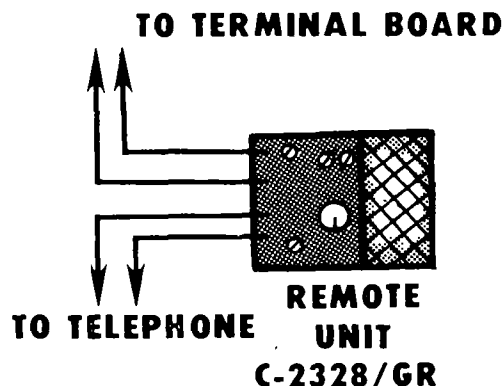
b. To install amplifiers and speakers in self-propelled units, the wire system may be run into the AN/VIC-1 intercommunications system as shown here.



A speaker LS-454 is hooked into the control unit C-2298 on the cannon. The wire from the terminal board is connected to the external wire terminals on the cannon. An obvious advantage of using this system is that all key members of the crew (chief of section,

gunner, assistant gunner) hear the fire commands. *Command emphasis* must be placed on keeping the intercommunications systems operational. Both the artillery mechanic and the battery communications chief are qualified to troubleshoot the system. Routine maintenance is covered in the weapon user's manual. The AN/VIC-1 does not permit simultaneous transmit and receive operations; so strict communications discipline must be maintained.

c. In towed units and self-propelled units that may have inoperative intercommunications systems, the remote unit C-2328/GR should be placed at the cannon and set up like this--



13-8. Training

The personnel who utilize the intrabattery wire communications system are responsible for establishing it. This means that the cannon section, FDC, and BOC personnel must *all* know how to lay and splice wire, dig it in or overhead it, and operate their respective pieces of equipment. Table 13-2 is a list of tasks and appropriate personnel to perform those tasks. This training should be integrated into the field training of the unit.

13-9. Low-Power Radios

a. Each howitzer section may have a low-power radio. These radios are not intended to be used as the primary means of communications between the howitzer and FDC. They are to be used to complement the

wire communications.

b. Because the positions the artillery will be occupying are spread out, installation of a hot loop back up to the wire system is quite time-consuming, and the hot loop would have the same vulnerabilities to disruption as the primary wire circuit. The radio provides a means of continuing the mission while the hot loop is being installed or during periods when wire is disrupted by enemy action.

c. The radio can be the primary means of communication while the battery is being laid and until the wire circuits are installed. It can also be used to transmit fire commands, if necessary, while the wire system is being march ordered for battery displacements. The radios can be used for communications with supplemental gun positions and to control immediate action while the battery is on the move. The low-power radios significantly enhance the battery internal communications capabilities but only if properly utilized. All radios are subject to detection by the enemy. *Do not* allow lax communications procedures just because the radio has low power. Train the howitzer sections to properly use radios and to smoothly change over from wire to radio in case the wire communications are disrupted.

13-10. Special Situations

In field exercises, the commander should insure that personnel get the opportunity to practice setting up the intrabattery communications system *at night*. Other items that should be emphasized are--

a. *Operation of the backup system.* The unit should frequently simulate a disruption in the primary system due to counterfire, etc.

b. *Simultaneous multiple fire missions.* Both the FDC and the BOC should be drilled.

c. *Use of telephones and radios while wearing a protective mask.* An operator must have considerable practice in projecting his voice while wearing a protective mask.

Table 13-2. Communications Tasks.

TASKS	PERSONNEL				
	FDC	BOC	HOW/GUN SECTION	OUTPOST PERS	COMMO SEC
Set up, operate, and maintain the telephone TA-312.	X	X	X	X	X
Install and operate the switchboard SB-22.	X				X
Install and operate the switchboard SB-993.	X	X			X
Check field wire WD-1 for both open and short circuits.	X	X	X	X	X
Repair broken wire lines.	X	X	X	X	X
Hook up the hot loop.	X	X	X		X
Hook up wire to an SB-16 and the terminal board.	X	X	X		X
In SP units, operate the intercommunications system AN/VIC-1. Interconnect CVC helmets, telephones and the loudspeakers LS-454 to the system.	X		X		X
Overhead and/or bury wire lines correctly.	X	X	X	X	X

13-11. Role Of The Battery Communications Chief

With the consolidation of wire teams at the battalion level, the role of the battery communications chief becomes one primarily of advising the commander on communications matters and troubleshooting equipment and the radio and wire systems. The two switchboard operators who are left in the communications section should be placed in the FDC to operate the SB-22. The communications chief's specific responsibilities are-

a. Assisting in the training of radio operators and telephone/switchboard operators.

b. Advising the battery commander on communications considerations during selection of a battery position.

c. Monitoring the maintenance of communications equipment in the battery by making frequent spot checks.

d. Supervising the installation and monitoring the operation of the battery wire system.

e. Monitoring radio traffic to insure adherence to proper procedures and communications discipline.

f. Coordinating with the battalion communications-electronics staff officer on matters of personnel, communications equipment and supplies, and other support.

g. Keeping personnel informed on the proper use of the CEOI and authorized codes.

h. Assembling and distributing the unit CEOI.



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CHAPTER 14

AMMUNITION CARE AND HANDLING

Section I. INTRODUCTION

14-1. General

On the modern battlefield the role of the ammunition section must take on *vital importance*. In recent years there has been a significant proliferation of ammunition within the field artillery, and still more ammunition is being developed. Until old stocks are depleted or declared obsolete, ammunition care and handling will remain a most difficult task. It is essential that battery supervisors keep themselves up to date on the latest changes in ammunition, fuzes, propellants, and fuze setters and wrenches. Two references *must* be on hand in each unit—TM 9-1300-251-20 and the appropriate weapon user's manual. TM 9-1300-251-20 gives technical and general maintenance information on conventional and improved conventional munitions for cannons, recoilless rifles, and mortars. Each weapon user's manual prescribes procedures for the handling, preparation, and maintenance of a specific caliber of ammunition as well as the procedures for operation and maintenance of fuze setters and wrenches.

14-2. Future Trends

a. In any future war, it is likely that the field artillery will be significantly outnumbered in terms of tubes. Offsetting this imbalance will require our batteries to fire considerably more ammunition per tube than does the enemy. To this undesirable situation may be added the necessity for frequent movement, probably one to six times per day. Most likely, one of the battery commander's primary concerns on tomorrow's battlefield will be supplying the battery and distributing ammunition to the pieces.

b. Looking still at tomorrow's battlefield, TACFIRE will provide a significant advantage in offsetting the imbalance of tubes through efficient, near instantaneous management of the firing batteries. For this to happen, TACFIRE requires a continuous, accurate accounting of ammunition. To the firing battery, this means keeping lots of projectiles, fuzes, and propellants segregated and keeping an accurate account of ammunition expenditures in each mission. Each cannon section checks with battery FDC and battery FDC checks with battalion FDC.

c. The battery must be capable of moving within a few minutes of notification. Keeping ammunition loaded on vehicles (if at all possible) and servicing the howitzer directly from the ammunition vehicle are desirable. This applies to both towed and self-propelled artillery. The ammunition vehicles, then, should be habitually associated with the howitzers. This means that when a howitzer receives a scheduled maintenance, so should the ammunition vehicle, that convoys should be tactically configured so that the ammunition vehicle follows the howitzer, and that if a howitzer is dug in or revetted the ammunition vehicle is in the same revetment.

d. Because of intense combat, battalion may have to have more control of its ammunition-carrying vehicles and the battery commander may be required to provide security for, and radio communications with, the ammunition section. Therefore, ammunition section personnel should be trained in map reading and radio operation. They should be the battery experts on ammunition and driving and should train others in these areas.

Section II. CARE AND HANDLING

14-3. General

a. A complete round of artillery ammunition contains all the components needed to get the round out of the tube and to burst at the desired place and time. The key to proper ammunition functioning is *PROTECTION*; protection from mud, heat, dampness, rough handling, fire hazards, and so on.

b. Safety is a matter of concern for all the battery personnel, and it requires special attention where ammunition is concerned. Supervision is critical, because improper care and handling can cause serious accidents as well as inaccurate fire. The following are some of the basic principles of proper ammunition handling.

(1) Never tumble, drag, throw or drop individual projectiles or boxes of projectiles.

(2) Do not allow smoking, open flames, or other fire hazards around ammunition storage areas.

(3) Inspect each round before it is loaded for firing. Dirty ammunition can damage the weapon, cause the breech not to close, or affect the accuracy of the round.

(4) Keep the ammunition dry and cool.

(5) Never make unauthorized alterations or mix components of one lot with another. (A further discussion of lots is in paragraph 14-11.)

(6) If a round has been rammed and then must be extracted, RETURN IT to the battalion ammunition section. The rotating band (fig 14-1) may be damaged or the fuze may have been damaged during extraction.

(7) On separate-loading ammunition, leave the eyebolt lifting plug screwed into the fuze well until the round is to be fired.

14-4. Projectiles

a. Each projectile must be inspected to

insure that there is no leakage of the contents, that the projectile is correctly assembled, and that the bourrelet and rotating band are smooth and free of burs and large

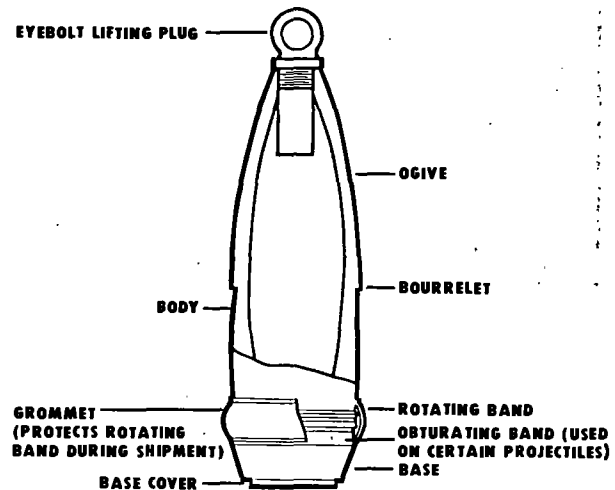


Figure 14-1. Exterior projectile parts.

dents. If the rotating band is burred or nicked, it should be smoothed with a flat, fine-grained file or with crocus cloth backed with a small block of wood. The rotating band and grommet must be secure and tight to prevent nicking and scarring the comparatively soft rotating band.

b. High-explosive projectiles issued for use with VT fuzes are standard projectiles with the fuze booster cavities deepened to accommodate the longer VT fuze. Each of these projectiles is issued with a removable supplementary charge so that the projectile may be used with either an impact, a mechanical, or a VT fuze.

THE SUPPLEMENTARY CHARGE IS REMOVED ONLY WHEN THE PROJECTILE IS USED WITH A VT FUZE AND MUST BE IN PLACE WHEN THE PROJECTILE IS USED WITH A MECHANICAL TIME FUZE OR AN IMPACT FUZE.

DO NOT ATTEMPT TO REMOVE THE SUPPLEMENTARY CHARGE BY ANY MEANS OTHER THAN THE LIFTING LOOP. IF THE CHARGE CANNOT BE REMOVED BY THE LIFTING LOOP, THE ROUND MAY BE DISPOSED OF OR FIRED WITH AN IMPACT FUZE OR AN MTSQ FUZE. THE DEEP CAVITY MAY BE LINED WITH A PAPER TUBE AND BOTTOM CUP, WHICH HELP SUPPORT THE HIGH-EXPLOSIVE FILLER. THIS LINING SHOULD NOT BE REMOVED AT ANY TIME.

14-5. Propelling Charges

Propelling charges, or powder, like other types of ammunition, must be kept cool and dry. Powder containers must be closed tight to keep moisture out.

b. Propellant bags must be firm, clean, and well laced or tied, and the increments must be inserted in the proper sequence. If the bags are torn or ripped, they should be turned in.

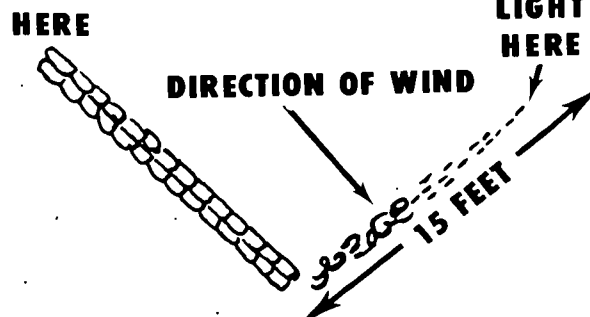
c. Do not try to save unused powder increments. They should be removed to some storage area, preferably 30 to 40 feet from the nearest weapon, until they can be burned or otherwise disposed of. If powder is to be burned, the following procedures should be followed:

(1) Select a burning site at least 200 feet from other personnel or equipment.

(2) Place charge increments in a single-layer row not more than 12 inches wide. The row should be placed so the powder will burn INTO the wind.

(3) Lay a train of combustible material about 15 feet long, perpendicular to and at the *DOWNWIND* end of the row of charge increments. Light this train at the end farthest from the increments. Place igniter powder in a train not more than 2 inches wide at the *UPWIND* end of the increments.

PLACE UNUSED FLASH REDUCERS AND IGNITERS

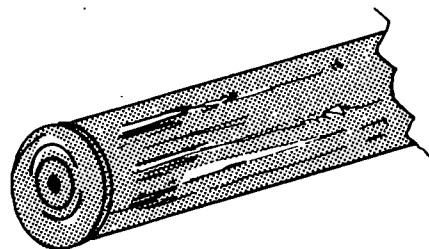


PROPELLING CHARGES AND IGNITER PADS SHOULD BE OPENED WITH A NONSPARKING INSTRUMENT TO PREVENT THEM FROM ACCIDENTALLY IGNITING.

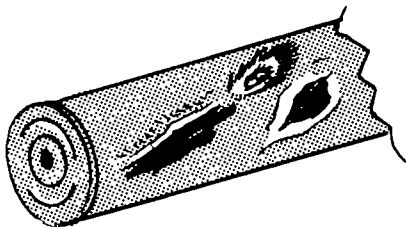
WHEN BURNING 175-MM CHARGES, BE SURE TO REMOVE THE CYLINDRICAL BAGS OF IGNITING POWDER (RED DEVILS) FROM THE POLYURETHANE TUBES.

Burning powder creates a very large flash and a lot of smoke. In a tactical environment, the XO must insure that burning powder does not compromise the camouflage and concealment effort. The burning of powder in a dummy position, if established, may aid in the deception effort.

14-6. Cartridge Cases

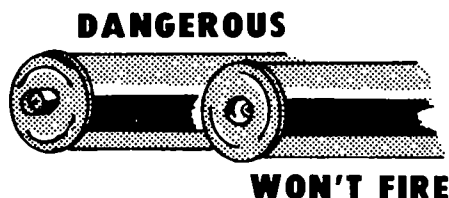


a. The cartridge case of semifixed ammunition should be checked for corrosion. Light brown staining is normal oxidation, but black, green, yellow, or white stains mean heavy corrosion, which must be cleaned off as soon as possible.



b. Check cartridges carefully for cracks, bulges, and burs.

c. The primer must be flush with the base of the case. If it sticks out too far, it's dangerous--if it sits in too far, the round will not fire.



14-7. Fuzes

NEVER FIRE A ROUND WITHOUT A FUZE THAT IS AUTHORIZED FOR THAT ROUND.

a. The specific fuzes available for each weapon system are discussed in the user's manual for the weapon.

b. Fuzes are sensitive to shock and must be handled with care.

c. Before fuzing a round, inspect the threads of the fuze and fuze well for cleanliness and crossed threads.

d. The fuze should be screwed into the fuze well slowly until resistance is met and then firmly seated with a sharp snap of the M16 or M18 fuze wrench, as appropriate.

PREMATURE DETONATION MAY OCCUR IF A FUZE IS NOT PROPERLY SEATED.

e. A projectile fuzed with a time fuze should not be lifted with a hand around the fuze. A slip of the hand might change the fuze setting.

f. During hailstorms or heavy rainstorms, projectiles with fuzes containing superquick elements should not be used. If they must be used, fuze settings should be changed from superquick to delay. It is possible for a fuze set on superquick to detonate when struck by hail or heavy rain.

UNITS MUST BE AWARE OF THE AMMUNITION RESTRICTIONS APPLICABLE TO THEIR CALIBER OF WEAPONS. THEY ARE CONTAINED IN THE USER'S MANUAL.

g. To prevent accidental functioning of the point-detonating elements of fuzes M564 and M548, the *fuzes must not be dropped, rolled, or struck* under any circumstances. Special care must be taken to insure that a fuzed round does not strike the breech of a weapon during loading.

h. Any mechanical time fuze that is set and not fired must be reset to SAFE and the safety wires (if applicable) must be replaced before the fuze is repacked in the original carton.

14-8. Primers

a. Primers are sensitive to both shock and moisture. Primers for separate-loading ammunition should be kept away from the propellant bags and left in their sealed containers until needed.

b. Primers for semifixed ammunition are attached to the base of the cartridge case. The best way to protect them is to leave them covered with a fiber container cap until needed.

THERE ARE TWO TYPES OF PRIMERS AVAILABLE FOR SEPARATE-LOADING AMMUNITION--THE MK2A4 (FOR THE M114A1 HOWITZER) AND THE M82 (FOR ALL OTHERS). MAKE SURE YOU HAVE THE RIGHT ONE.

c. Inspect all primers prior to use for signs of corrosion. If a seal has been broken it is very likely that the primer has been affected by moisture and should be turned in.

14-9. Flash Reducers

a. Some propellants burn at such a high rate that flash reducers containing black powder and potassium sulfate must be used to reduce flash at night. The flash reducers also speed up the combustion of unburned propellant gases, which helps prevent excessive muzzle blast.

b. Flash reducers absorb moisture readily, so it is critical that they be kept *DRY*. Keep them off damp ground and sealed in their containers until needed for use.

c. Discarded flash reducers should be disposed of in the same manner as igniter pads (para 14-5).

FLASH REDUCERS ARE HIGHLY FLAMMABLE. IT'S CRITICAL THAT THEY BE DISPOSED OF PROPERLY TO PREVENT INJURY.

14-10. Chemical Projectiles

a. Some chemical projectiles, because of their contents, require special handling and storage. These are the toxic chemical

and the white phosphorus (WP) shells.

b. When toxic chemicals are being fired, all personnel in the area should wear protective masks and anyone handling the shell should wear gloves. There should be an ample supply of decontaminating agents available close by in case they're needed. If possible, these shells should be stored away from other types of ammunition and downwind of the battery area.

c. The WP round should be stored upright on its base, but any time the temperature of the ammunition reaches 110° F the round *MUST* be stored this way. If it's not, the filler will melt and shift to one side of the cavity in the projectile, which will cause the projectile to be unbalanced. The WP shells should be in an area free of all combustibles and away from other ammunition if possible.

14-11. Segregation Of Ammunition Lots

a. Different lots of propellant burn at different rates and give slightly different effects in the target area. For this reason, the registration corrections derived from one lot do not necessarily apply to another lot. Ammunition *MUST be segregated by lot* and in the case of separate-loading ammunition, by weight zone.

b. The FDC will designate the lot of ammunition to be fired for each mission (or it will be standardized), so the lot designator should be prominently displayed for each stack of ammunition.

c. In the field storage area, be it on vehicles or in a dump, lots of ammunition should be roped off with communications wire or twine and conspicuously marked with a cardboard sign or some such marker.

Section III. FIELD STORAGE OF AMMUNITION

14-12. Hazards

a. The four greatest hazards to ammunition in the battery area are--

WEATHER
ENEMY FIRE
IMPROPER HANDLING

and

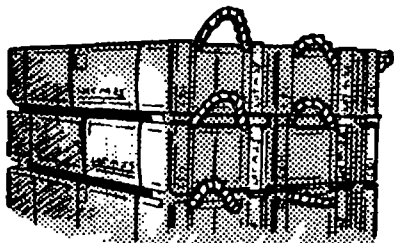
CARELESS SMOKERS

so,

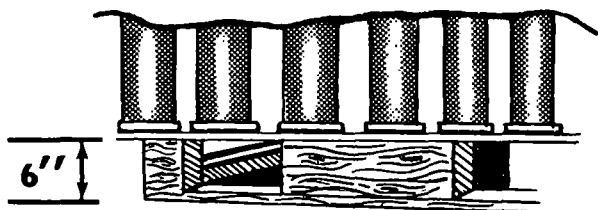
regardless of the method of storage, these hazards must be given consideration. Specific storage techniques are discussed later

in this section, but here are some general considerations.

(1) Stack ammunition by type, lot number, and weight zone.



(2) If ammunition is being stored on the ground, use good strong dunnage at least 6 inches high under each stack.

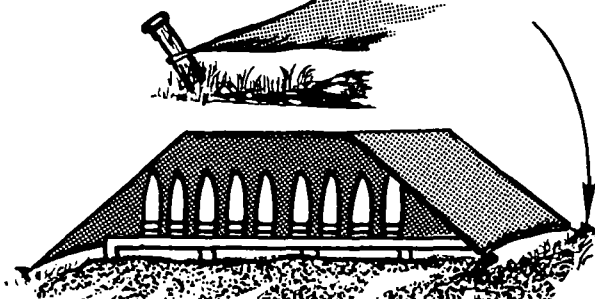


(3) Keep the ammunition dry and out of direct sunlight by storing it in a vehicle or covering it with a tarp. Be sure adequate ventilation is provided.

(4) Provide ammunition, if off-loaded, as much protection from enemy indirect fires as time and available materials allow. If sandbags are used for protection, keep the walls at least 6 inches from the stacks and the roof at least 18 inches from the stacks to insure proper ventilation.

b. Particular attention must be paid to ammunition temperature. Most ammunition

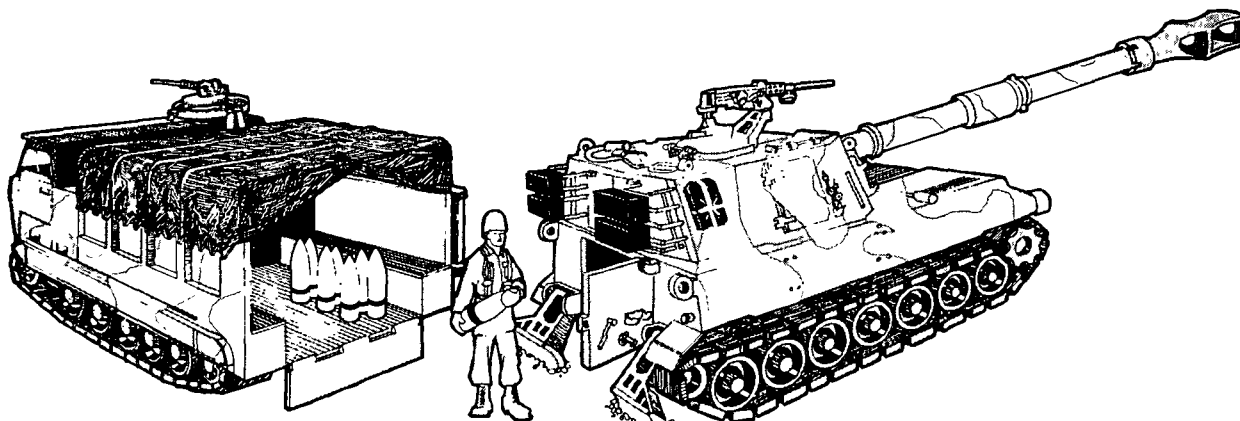
PAULIN COVER SECURELY STAKED



components can be stored at temperatures as low as -80°F for periods of not more than 3 days and as high as $+160^{\circ}\text{F}$ for periods of not more than 4 hours per day. An increase in malfunctions may be experienced with some VT fuzes if fired when the temperature is below 0° or above $+120^{\circ}\text{F}$. Powder temperature affects the muzzle velocity of a fired round and is a matter of frequent concern to the FDC. At least two howitzer sections should be designated to keep track of the powder temperature. A powder thermometer is inserted into the top powder increment in the canister, and care must be exercised to insure the thermometer does not touch metal.

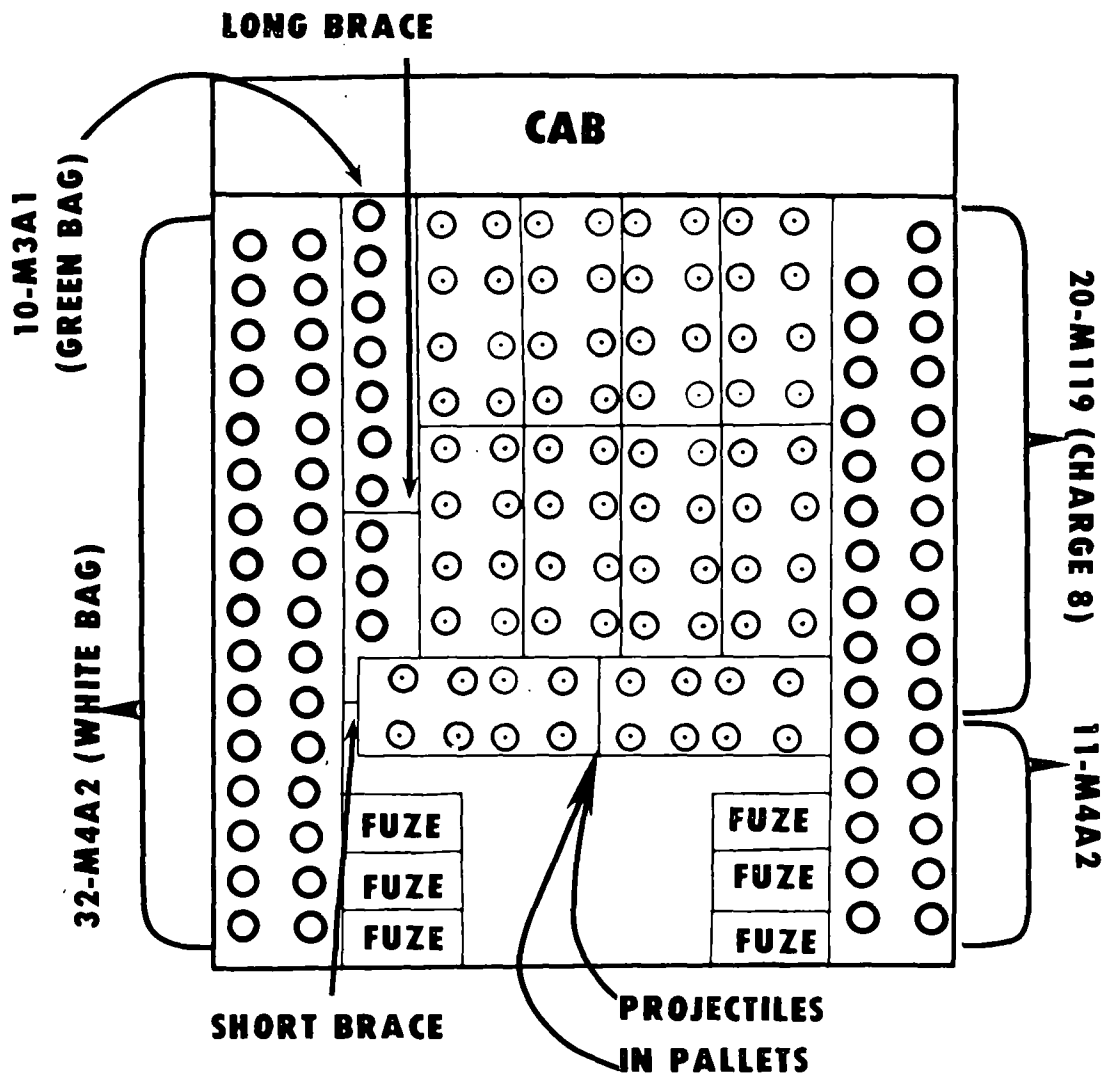
**CANNON SECTIONS MUST BE
CAREFUL NOT TO FIRE THE
POWDER THERMOMETER.**

c. Only enough ammunition to meet current needs should ever be prepared at the pieces. In SP units, the M548 ammunition



carrier is the companion vehicle to the howitzer and serves as an excellent area from which to service the weapon as well as a storage area for ammunition. The M548 should always be positioned with its howitzer and replenished in position by the battery ammu-

nition section. Figure 14-2 shows a suggested method of loading the M548. Ammunition should be left in pallets until needed for use. Figures 14-3 and 14-4 show recommended methods of securing the ammunition.



Notes.

1. Powder charges must be secured in the upright position.
2. Tiedowns over the top of ammunition pallets and secured to the floor of the carrier (to existing brackets) will keep the load from shifting.
3. Powder mix is arbitrary and will vary from unit to unit, depending on the tactical situation.
4. Load indicated is for an M109A1 howitzer section.

Figure 14-2. A typical M548 ammunition load.

MATERIALS

- ① 2 pieces angle iron $\frac{1}{4}$ " x 2" x $1\frac{1}{2}$ " x 10'8" (top)
2 pieces angle iron $\frac{1}{4}$ " x 2" x 2" x 10'4" (bottom)
- ② 4 pieces angle iron $\frac{1}{4}$ " x 2" x 16"
- ③ 4 pieces angle iron $\frac{1}{4}$ " x 2" x 12"
- ④ 14 pieces strap iron $\frac{1}{4}$ " x $1\frac{1}{2}$ " x $3\frac{1}{2}$ "
- ⑤ 6- $\frac{1}{2}$ " x $1\frac{1}{2}$ " capscrews with lockwashers
- ⑥ 4-4 $\frac{1}{2}$ " to 5" butt hinges

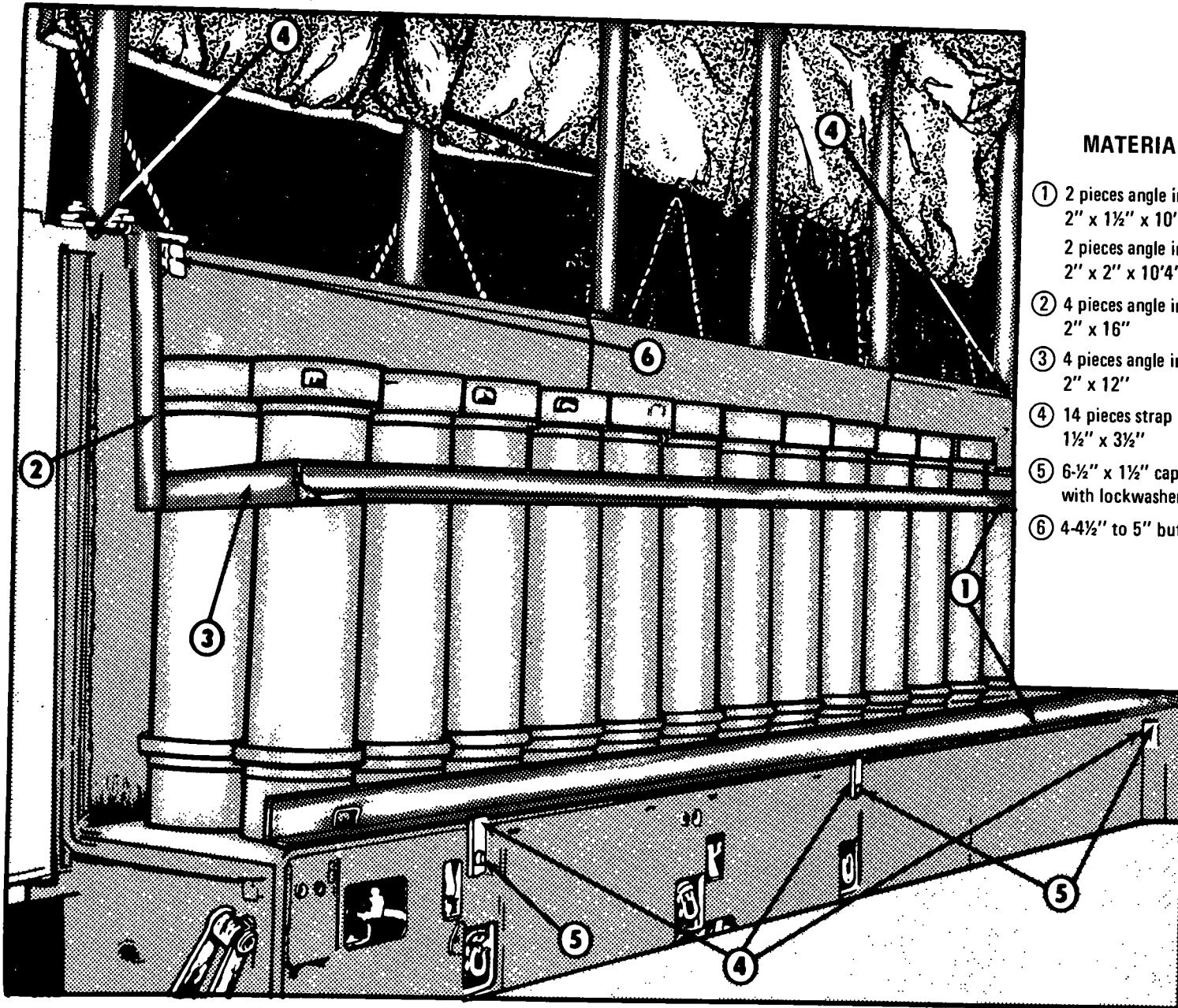
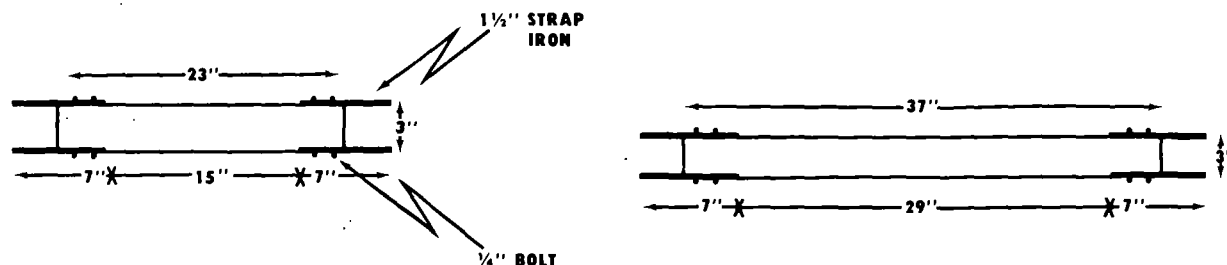


Figure 14-3. Canister holddown brackets.



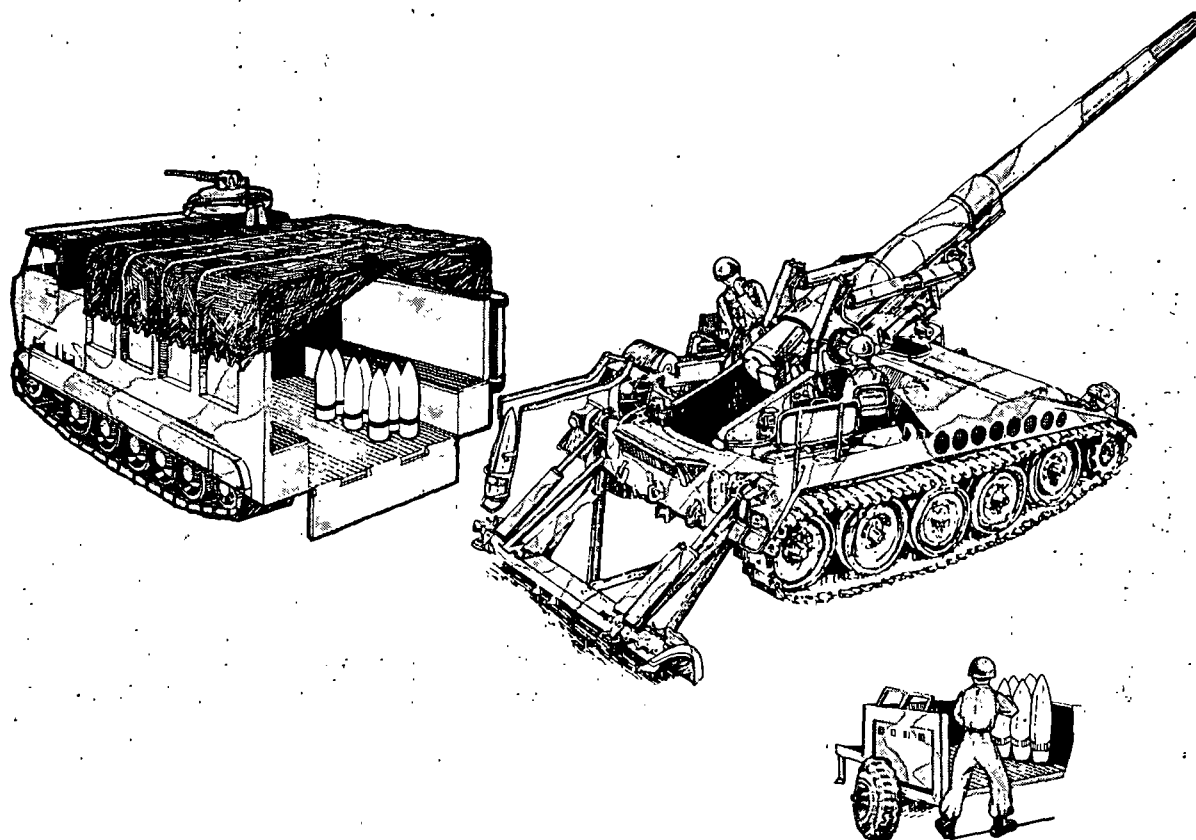
These braces should be used with the full load shown in figure 14-2. The short brace is used for three pallets and the long one for two. When either type of brace is used, the pallet top will be fitted between the strap iron brackets in the 3-inch gap. Two braces will be used between pallets.

Figure 14-4. Pallet braces for securing ammunition pallets.

BE SURE PALLETS ARE ADEQUATELY CRIBBED AND SECURED TO PREVENT THEM FROM SHIFTING DURING MOVEMENT.

d. The M332 ammunition trailer is equally effective in a highly mobile situation, particularly in 8-inch howitzer and 175-mm gun units.

e. In towed units, the prime mover, loaded with ammunition, should be positioned near the howitzer. Ammunition should be left loaded until it is prepared for firing. Other ammunition is stored on the weapon itself, on the prime movers, on the battery ammunition section vehicles, or at a battery ammunition dump. The establishment of a battery ammunition dump is a matter of command decision, however, because it *seriously* impairs the mobility of the battery.



14-13. Accidents

Firing accidents are generally serious in nature, so all supervisory personnel should know the immediate action to be taken. Here are some general guidelines for use in the development of a sound SOP--

a. Render first aid to injured personnel; then call for medical assistance.

b. If the ammunition or equipment presents further danger, move all personnel out

of the area.

c. Do not change any settings on, or modify the position of, the cannon in any way until an investigation has been completed.

d. Record the lot number of the ammunition involved in the accident or malfunction and report it to the battalion ammunition officer. If there is good reason to suspect a particular lot of ammunition, its use should be suspended by the XO.

Section IV. MISFIRE PROCEDURES

14-14. General

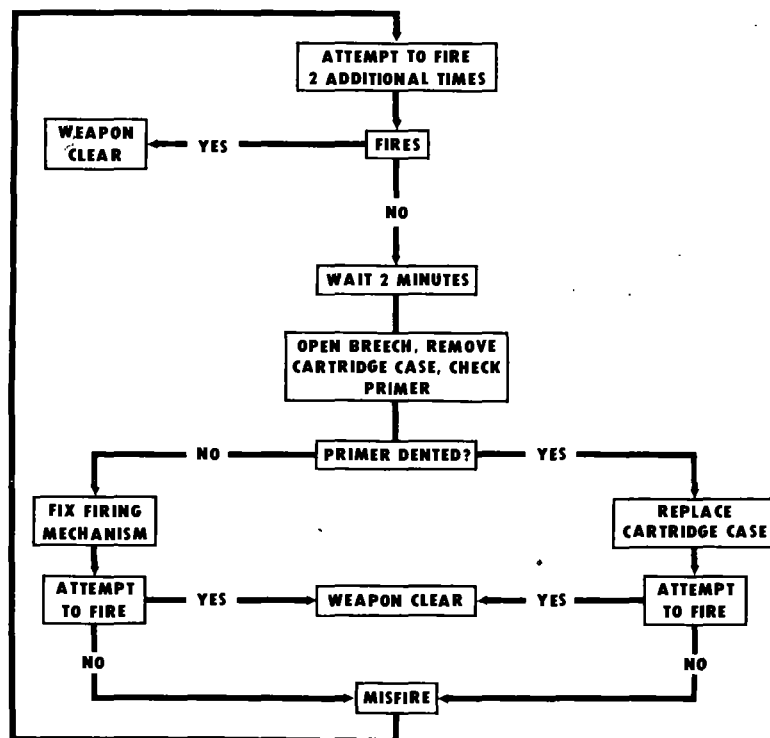
Misfires *do* occur, and when they do there are specific things that must be done within specific time limits. For that reason, personnel must be thoroughly familiar with the applicable misfire procedures and the hot tube loading precautions. Figures 14-5 through 14-7 show the misfire procedures for semi-fixed and separate-loading ammunition.

14-15. Hot Tube Precautions

a. Do not load a round until immediately prior to firing.

b. Fire or remove any round within 5 MINUTES after it has been loaded.

c. If the round cannot be removed or fired within 5 minutes--



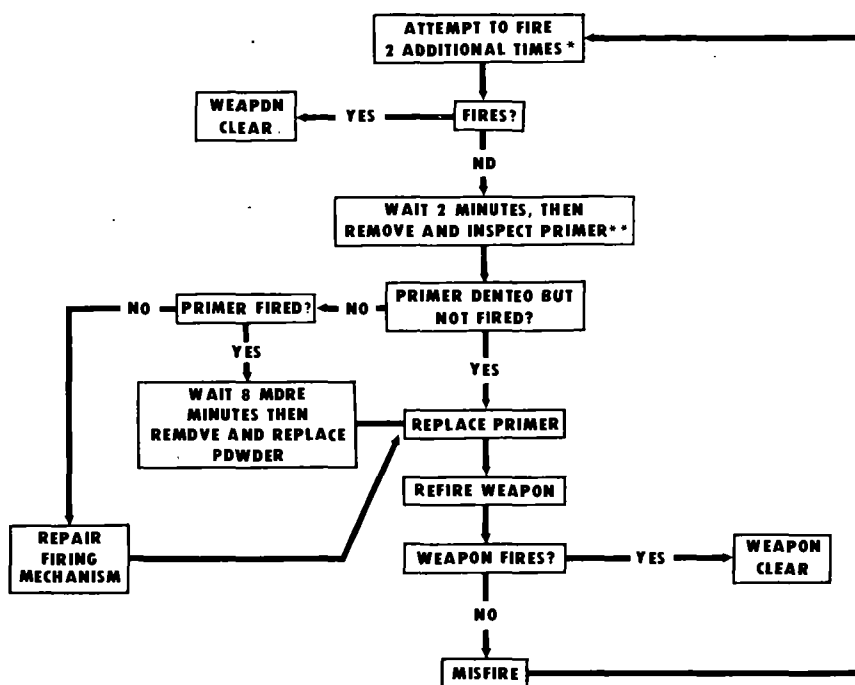
The misfire procedures for semifixed ammunition, hot tube, are the same as those for a cold tube with the exception that the hot tube precautions (para 14-15) must be observed.

Figure 14-5. Misfire procedures, semifixed ammunition, cold tube.

(1) REMOVE THE PRIMER AND PROPELLING CHARGE OR CARTRIDGE.

(2) HAVE THE CREW EVACUATE THE WEAPON.

(3) LET THE WEAPON COOL FOR 2 HOURS BEFORE ATTEMPTING TO EXTRACT THE ROUND. Call ordnance, if necessary, to assist in extracting the round.



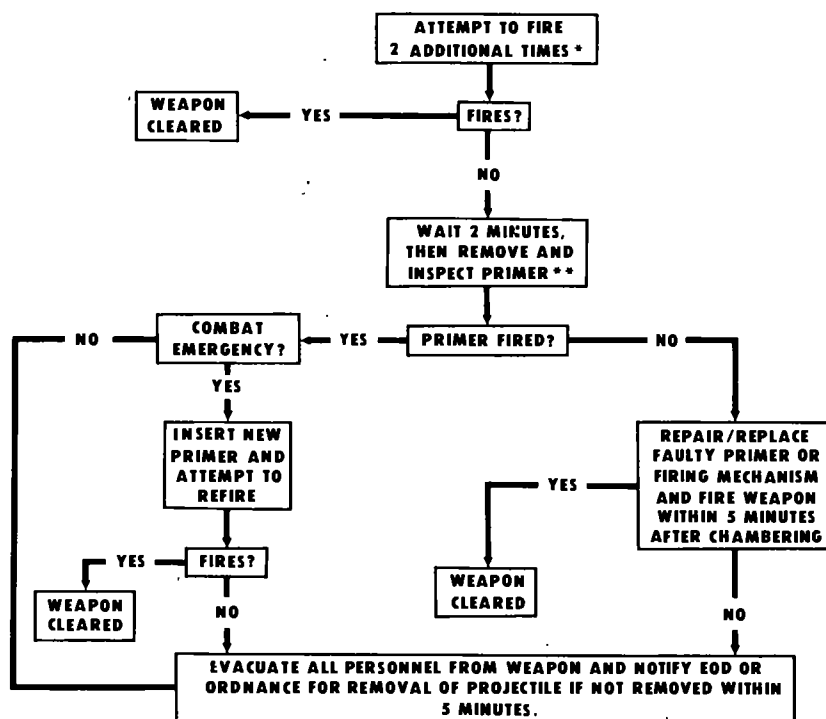
*Do not attempt to fire the 175-mm gun two additional times if firing zone 3.

**If firing the M109A1, charge 1, the following apply (see note):

1. Open rear of cab.
2. Position tube so primer can be expelled outside if a sticker is involved.
3. Open the firing lock.
4. If a sticker is involved, refire with charge 4 or higher. If not, inspect the primer and proceed through the remainder of the misfire procedures.

Note: Occasionally, in firing charge 1 with the M109A1, a round will lodge in the tube after normal functioning of the ignition train. This round is called a **STICKER**, and when it occurs, gases under high pressure are trapped in the chamber.

Figure 14-6. Misfire procedures, separate-loading ammunition, cold tube.



*Do not attempt to fire the 175-mm gun two additional times if firing zone 3.

**If firing the M109A1 with charge 1, observe the sticker precaution in the preceding figure.

Figure 14-7. Misfire procedures, separate-loading ammunition, hot tube.

14-16. Training

a. Ammunition training has traditionally been a weak area. Cannoneers seldom get to practice setting time fuzes or cutting propellant charges until the battery goes to the field to conduct live firing. There are several training extension course (TEC) lessons on ammunition to enhance individual training. Additionally, the Field Artillery School has an excellent selection of ammunition training materials.

b. Collective training can be enhanced by the use of training rounds, which are available through the local training aids support office. New training rounds are constantly being introduced into the training aids inventory. These rounds are designed to exercise the entire howitzer crew—from loading, cribbing, and handling ammunition to setting fuzes, cutting charges, loading and firing. Keep an up-to-date TASO catalog and take advantage of these devices. More tips on training ammunition section personnel are in chapter 17.

CHAPTER 15

DUTIES OF SAFETY PERSONNEL DURING SERVICE PRACTICE FIRING

Section I. INTRODUCTION

15-1. General

a. The military profession is, by its very nature, a dangerous business. An honest error or an unforeseen accident can have fatal results. Safety must always be on the minds of everyone. The artilleryman, perhaps more than others, must constantly guard against that one round fired in error. Its effects can be enormous. The round does not know the difference between civilians and military. One friendly round falling on friendly troops can destroy morale and the close teamwork necessary within the combined arms team.

b. The importance of safety is well recognized. The concern for safety can, however, be counterproductive. It can influence training to the extent that realistic combat training is nearly impossible. It is the duty of every leader to be sure that concern for safety is effective. At the battery, there is much that can be done. Each supervisor must know his job before supervising troops in the conduct of live ammunition firing. Most accidents are the result of ignorance, not carelessness. The chief of a cannon section must know his job and his responsibility for accurately firing the data given his section. The same applies to the forward observer and fire direction personnel in the development of those data.

c. This chapter reinforces AR 385-63 and pertains primarily to peacetime safety practices and procedures. However, the information herein can also be applied in combat situations. *In any instance where local range regulations contradict the material in this chapter, the local range regulations must be followed.* The responsibilities for safety are fixed as follows:

(1) *THE RANGE OFFICER*--provides the officer in charge (OIC) of firing with a

safety card stating the geographic limits of the impact area into which all artillery fire must be directed.

(2) *THE OFFICER IN CHARGE OF FIRING*--is normally the commander or OIC of the unit conducting firing. He is responsible for insuring that rounds, when fired, land within the designated impact area.

(3) *THE CANNON SAFETY OFFICER/NCO*--is directly responsible to the OIC of firing for safety at the cannon. These duties may be performed by a certified safety officer or noncommissioned officer in the grade of E6 or above. Normally, this duty will be performed by the XO or chief of firing battery. The safety officer/NCO must be competent and qualified to perform his duties, as he is responsible for insuring that all rounds fired are within the safety limits as shown on the safety diagram. Specific duties are covered in subsequent paragraphs.

(4) *THE EXECUTIVE OFFICER*--is responsible for insuring that safe practices are followed in ammunition handling, in laying for direction and elevation, and in all other operations performed by the firing battery.

(5) *THE FIRE DIRECTION OFFICER*--prepares the safety diagram and verifies the plotting of safety limits on the firing chart. He insures that fire commands sent to the cannons are within the specified limits.

(6) *THE HOWITZER/GUN CHIEF OF SECTION*--accepts final responsibility for the safety of the weapon and crew after the safety officer/NCO gives the clearance to fire. He insures that his section fires only serviceable rounds of authorized ammunition with the proper charge and that the firing data sent to the section are properly set on the weapon. The commander must insure

that all his personnel are qualified to perform their safety duties. A sample test for the qualification of safety personnel is in appendix E.

15-2. Duties Of The Safety Officer/NCO

a. The safety officer/NCO must be thoroughly familiar with five references. They are *AR 385-63*, *FM 6-50*, *TM 9-1300-203*, the appropriate *TM for the weapon*, and *post range regulations*. His specific duties are--

(1) Before firing--

(a) Verify that the safety card applies to the unit firing, that the unit is in the correct location and that the data are correct.

(b) Verify the safety diagram (para 15-4).

(c) Check the weapons for correct boresighting.

(d) Verify the lay of the battery.

(e) Verify the minimum quadrant elevation determined by the executive officer.

(f) Compare the XO's minimum QE with the quadrant elevation for minimum range shown on the safety diagram and use the larger of the two as the minimum QE.

(g) Supervise and check the emplacement of safety aids (stakes, safety tape, or other devices).

(h) Verify that the ammunition to be fired is of the type specified on the safety card.

(i) Insure that the chiefs of section are informed of maximum and minimum quadrant elevations, right and left deflection limits, and minimum fuze settings.

(j) Verify that range clearance has been obtained by checking with the officer in charge of firing.

(k) Ascertain or confirm that the visible portion of the impact area is clear of personnel.

(l) Insure compliance with Department of the Army regulations, post range regulations, and local special instructions pertaining to safety. When the checks required before firing have been made, the safety officer informs the OIC that it is safe for the battery to fire.

(2) During firing--

(a) Verify the serviceability of ammunition.

(b) Insure that the charges, projectiles, and fuzes being fired are only those prescribed on the safety card.

(c) Insure that rounds are not fired below the minimum quadrant elevation or above the maximum quadrant elevation.

(d) Insure that rounds are not fired outside the lateral safety limits specified on the safety card.

(e) Insure that time-fuzed rounds are not fired with fuze settings that are less than the minimum time prescribed on the safety diagram.

(f) Require that unused powder increments be displayed for each round to be fired.

(g) On all commands that are unsafe to fire, command UNSAFE TO FIRE and give the reasons therefor. Examples are--

1. UNSAFE TO FIRE, 3 MILS OUTSIDE RIGHT SAFETY LIMIT AND 20 MILS ABOVE MAXIMUM QUADRANT ELEVATION.

2. UNSAFE TO FIRE, 5 MILS BELOW MINIMUM QUADRANT ELEVATION.

(h) Apply registration corrections to the safety limits immediately after registration.

(i) By a positive act, such as a hand signal or a voice command, indicate to the chief of section when it is safe to fire.

(j) Report accidents and malfunctions of ammunition to the officer in charge of firing and make those reports required by post range regulations and AR 385-63.

(k) Bring to the attention of the OIC any unsafe conditions observed and suspend firing until these conditions have been corrected. Examples of unsafe conditions are--

1. Safety features of the weapon not operable.
2. Powder bags exposed to fire.
3. Personnel smoking near pieces.
4. Improper handling of ammunition.
5. Time fuzes previously set and not reset to safe.
6. Personnel or aircraft directly in front of the weapons.
7. Primer inserted into the firing assembly before breech is closed (separate-loading ammunition).
8. Failure to inspect powder chamber and bore after each round is fired.
9. Failure to swab powder chamber after each round of separate-loading ammunition is fired.

10. Misfires. (Para 14-14.) The safety officer/NCO must insure that the cannon personnel follow the prescribed misfire procedures.

b. The safety officer performs his duties in a manner that insures compliance with all safety regulations and limits; however, he should not use procedures that will unnecessarily delay the delivery of fire.

15-3. The Safety Card

a. The range officer prepares a safety card prescribing the hours of firing, the areas in which firing will take place, the location of the gun position, the limits of the impact area, and other pertinent data to provide a safety zone that will insure that rounds with maximum dispersion fall in a safe area. The officer in charge of firing gives the card to the FDO, who constructs a diagram showing the limits prescribed on the safety card. This data is then verified by the safety officer/NCO. Figure 15-1 shows a typical range safety card and shows the format that should be used.

RANGE SAFETY CARD			
UNIT/STR:	1st Bn, 64th FA	DATE-TIME GP:	0710 1630 1 May 76
FIRING POINT:	27531 15489	AREA:	SMA
WEAPON:	155H (SP)	AMMUNITION:	SH, HE, FZ M557, M564, M514
TYPE OF FIRE: High & Low Angle			
DIRECTION LIMITS: (Ref GN): LEFT		1675	MILS, RIGHT 2435 MILS
LOW ANGLE PD MINIMUM RANGE		3700	METERS, MINIMUM CHARGE 4 GB
FUZE TI, VT & HI ANGLE MINIMUM RANGE		3700	METERS, MINIMUM CHARGE 4 GB
MAXIMUM RANGE TO IMPACT		7000	METERS, MAXIMUM CHARGE 4 GB
SPECIAL INSTRUCTIONS: Apply +5.5 seconds to Time of Flight corresponding to Range <u>3700 meters</u> to establish Minimum Time for Fuze VT.			
From az 1675 to az 1865, minimum range 4100 meters Apply +5.5 seconds to time of flight corresponding to range <u>4100 meters</u> to establish minimum time for fuze VT. White bag not authorized.			

Figure 15-1. Range safety card.

b. From the range safety card the FDO prepares a safety diagram and a safety T for the cannon safety officer/NCO. The safety T is a convenient method of arranging the safety data. A 3" x 5" card may be used. Here is the safety T for the data computed in paragraph 15-4.

483		
3575	3385	2815
227	206	
14.1	12.6	
20.0	19.0	

(Maximum QE)
(Deflection limits)
(Minimum QE)
(Minimum time, M564)
(Minimum time, VT)

This format is especially handy for distribution to the FDC and howitzer section chiefs.

Section II. COMPUTATION OF SAFETY DATA

15-4. Construction Of The Safety Diagram

Prior to registration, the FDO must construct the basic safety diagram (fig 15-2) using the following procedures:

a. To determine the deflection limits--

- (1) Draw the azimuth limits listed on the range safety card as shown in figure 15-2.
- (2) Determine the difference in mils between the azimuth of lay and each of the azimuth limits.

(3) Apply the angular difference to the base deflection of the howitzer. Remember, an increase in azimuth causes a decrease in deflection, and vice versa.

b. To determine the minimum quadrant elevation--

- (1) Compute site to the highest point on the minimum range line(s).
- (2) Determine elevation for the minimum range(s), applying any known corrections.
- (3) Add site to elevation; the sum is the minimum quadrant elevation.

c. To determine the minimum fuze setting for fuze time--

(1) Compute the fuze setting corresponding to the elevation for the minimum range.

(2) Add any known fuze correction.

d. To determine the minimum fuze setting for fuze proximity (VT)--

(1) Determine the time of flight cor-

responding to the elevation to the minimum range.

(2) Add 5.5 seconds.

(3) If the sum is not a whole second, express up to the next higher whole second.

e. To determine the maximum quadrant elevation--

- (1) Compute site to the lowest point on the maximum range line(s).
- (2) Determine elevation for the maximum range(s), applying any known corrections.
- (3) Add the site and elevation. The sum is the maximum quadrant elevation.

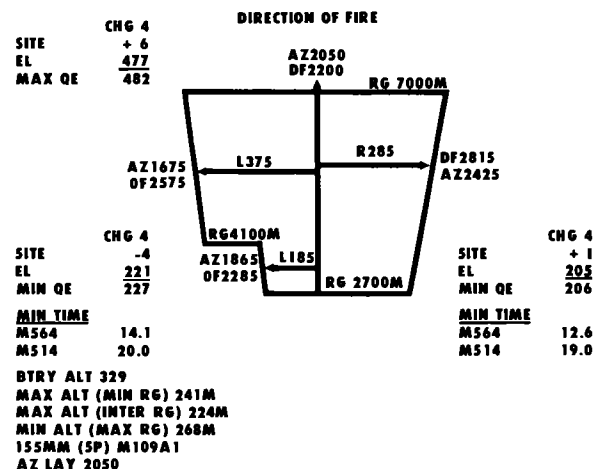


Figure 15-2. Safety diagram.

15-5. Safety Aids

a. The safety officer should use whatever visual aids he can devise to help him in verifying that howitzers are laid within the

safety limits. Three such aids are *safety stakes* (towed weapons), *safety tape* (M109/109A1), and the electrical-mechanical *safety officer's aid* for the M109/109A1, which is available through the local Training Aids Services Office (TASO). These aids, each of which is discussed below, should be used as guides for any deflection (quadrant on the M109/M109A1) not within 20 mils of a safety limit. If a deflection announced IS within 20 mils of a limit, the safety officer should go to the piece and verify sight settings.

b. To emplace safety stakes--

(1) Set on the sight, in turn, the left, intermediate, and right deflection limits and take up a proper sight picture on the collimator or aiming posts.

(2) Sight through the breech end of the tube and, sighting along the left edge of the tube for the left limit and the right edge of the tube for the right limit, align the safety stakes. They should be firmly driven into the ground approximately 10 feet in front of the tube.

c. Safety tape provides a convenient and fast method of verifying firing data on the M109/109A1 weapons. As shown in figure 15-3, an index is placed on the movable portion of the hull. Then the weapon is traversed to left and right limits and at each limit a piece of tape is placed on the lower hull under the index. By the same method, tape can be placed on the tube and on the front of the upper hull to indicate elevation limits (fig 15-3).

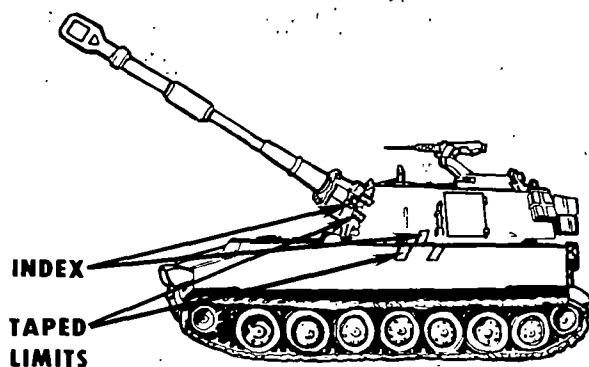


Figure 15-3. Safety tape.

d. The Safety Officer's Aid mounts on the weapon. It incorporates microswitches that cause an audio warning and cut off hydraulic power when deflection and quadrant limits are reached.

15-6. Safety Limits After Registration

The FDO must construct the GFT setting obtained from registration and record the total deflection correction. He then modifies his safety data, using the following procedures:

a. To determine the minimum quadrant elevation--

(1) Move the manufacturer's hairline on the GFT to the minimum range.

(2) Read the minimum elevation under the elevation gageline.

(3) Add the site computed prior to registration.

b. To determine the minimum fuze setting for fuze time--

(1) Move the hairline on the GFT to the minimum range.

(2) Read the minimum safe time under the time gageline.

c. To determine the minimum fuze setting for fuze proximity (VT)--

(1) Determine the minimum elevation as above.

(2) From the tabular firing tables determine the time of flight corresponding to the minimum elevation.

(3) Add 5.5 seconds to the time of flight. If this sum is a whole second, it is the minimum safe time for proximity (VT) fuze. If it is not a whole second, express up to the next higher second.

d. To determine the maximum quadrant elevation--

(1) Move the hairline on the GFT to the maximum range.

(2) Read the maximum elevation under the elevation gageline.

(3) Add the site computed prior to registration.

e. After registration, correct the deflection limits of the basic safety diagram by applying the total deflection correction to each deflection limit.

15-7. Special Situations

a. High-angle fire.

(1) To determine the maximum quadrant elevation--

(a) Compute site to the highest point on the minimum range line to the nearest mil.

(b) Determine the elevation for the minimum range line to the nearest mil.

(c) Add site and elevation to obtain the maximum quadrant elevation for minimum range.

(2) To determine the minimum quadrant elevation--

(a) Compute site to the lowest point on the maximum range line to the nearest mil.

(b) Determine elevation to the maximum range to the nearest mil.

(c) Add site and elevation to obtain the minimum quadrant elevation for maximum range.

(3) To correct deflection limits--

(a) Modify the right deflection limit to the left by the maximum amount of drift for all charges to be fired.

(b) Modify the left deflection limit to the left by the minimum amount of drift for all charges to be fired.

(4) After registration, construct a GFT setting and recompute minimum and maximum quadrant elevations and deflection limits. Deflection limits will be modified as indicated above and by the total deflection correction.

b. *Shell illuminating.* When the illuminating projectile is to be employed, the FDO computes the basic safety diagram in the same manner as for shell HE with the excep-

tion of minimum and maximum quadrant elevations.

(1) To determine the minimum quadrant elevation--

(a) Enter the tabular firing tables (TFT) with the minimum range and determine the corresponding elevation and the change in elevation necessary for a 50-meter change in height of burst.

(b) Compare the battery altitude to the maximum altitude at minimum range and express the vertical interval (VI) to the nearest 50 meters.

(c) Subtract the VI from 750 and divide this quantity by 50 to determine the number of 50-meter increments necessary to move the burst of the round to the ground.

(d) Multiply the number of increments by the change in elevation determined previously and subtract this amount from the elevation corresponding to the minimum range. The result, expressed to the nearest mil, is the minimum QE.

(e) Minimum time is the M564 fuze setting corresponding to minimum range (read under the time gageline).

(2) To determine the maximum quadrant elevation--

(a) Enter the range-to-impact column of the TFT with the maximum range or the next lower listed range. Express the QE corresponding to this range to the nearest mil.

(b) Apply site computed for HE to the result. This is the maximum QE.

c. Improved conventional munitions.

(1) The deflection limits for improved conventional munitions (ICM) are determined in the same manner as those for shell HE. The range safety card *should include* special buffer zones required for shell ICM.

(2) To determine the minimum quadrant elevation (155-mm SP howitzer M109A1 is used as an example)--

(a) Enter the ICM addendum, table

A, column 1, with the HE minimum QE or the nearest listed value and extract the correction factor corresponding to the projectile being fired.

(b) Add this correction factor to the HE minimum QE to determine the minimum QE for shell ICM. Use the M564 fuze setting corresponding to the minimum range from either the GFT or the TFT as the minimum time.

(3) To determine the maximum quadrant elevation--

(a) Enter the range-to-impact column of the ICM addendum with the maximum range *OR THE NEXT LOWER LISTED VALUE* and extract the appropriate correction factor and the HE quadrant elevation corresponding to that range. If no range-to-impact column is listed, the maximum QE for shell HE is used.

(b) Add the quadrant elevation and the correction factor to the site for shell HE at maximum range to determine the maximum QE.

d. Heavy artillery. Because of the great range and resulting drift involved in firing the 175-mm gun, drift for low-angle fire **MUST** be included in the computation of safety limits prior to registration. Determine the drift for all charges being fired and apply

the largest value to all deflection limits.

e. Direct fire. When direct fire is employed, the computation of safety data is the same as that prescribed for low-angle firing. For range, even though firing is conducted by use of the range scale on the direct fire telescope, the safety officer must verify the elevation to insure that rounds fired will be safe. In order to do this, the safety officer must verify safety settings by using the gunner's quadrant or the elevation scale to insure that rounds are not fired below minimum quadrant elevation or above maximum quadrant elevation.

f. White phosphorus shell. Since shell WP is heavier than shell HE, 300 meters should be added to each minimum range to determine the minimum QE for the WP shell. The maximum QE for the WP shell is the same as for the HE shell.

g. Shell smoke. Safety data for shell smoke are computed in the same manner as for shell HE. Minimum time is the M564 fuze setting corresponding to minimum range **UNLESS** the round is fuzed with the M501-series fuze instead of the M565. When an M501-series fuze is used the correction factor in the TFT for fuze M520A1 must be applied to the M564 fuze setting corresponding to minimum range to determine the minimum time.

1

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PART FOUR

TRAINING



- **CHAPTER 16 - DEVELOPING THE CANNON BATTERY TRAINING PROGRAM**
- **CHAPTER 17 - TRAINING THE CANNON BATTERY**
- **CHAPTER 18 - MAINTENANCE PROCEDURES AND TRAINING**

CHAPTER 16

DEVELOPING THE CANNON BATTERY TRAINING PROGRAM

Section I. INTRODUCTION

THE ARMY TRAINING MISSION OBJECTIVE IS TO ATTAIN AND MAINTAIN THE STATE OF OPERATIONAL READINESS REQUIRED TO CONDUCT COMBAT OR OTHER OPERATIONS IN ACCORDANCE WITH ASSIGNED MISSIONS.

16-1. General

Preparing and conducting training properly is one of the battery commander's most difficult, but most important, jobs. Field artillery batteries are actively engaged in various administrative and support functions that divert their energies from training in their fighting skills. Technical proficiency inspections (TPI), on-duty education, ROTC support, salutes, and range police can seriously detract from time available for training in the battery in its conventional fire support mission. The purpose of this chapter is to present ideas and tools to assist the cannon battery commander in overcoming these training diversions.

16-2. Army Training Policy

a. Under the Army training philosophy, the authority and responsibility for detailed planning, organization, conduct, evaluation, and supervision of training are delegated to the battalion or separate battery level. Decentralized training focuses all training effort at the battery level, where the job is actually performed. This means that the battery commander must be able to determine specific training objectives based on his unit's mission, the battalion commander's goals and guidance, the available training resources, and the present level of training.

b. Another aspect of this philosophy is that all commanders establish and support *prime time* for conducting mission-related training. Mission-related training is indi-

vidual or collective training that contributes directly to the accomplishment of the unit mission. AR 350-1 specifically precludes special duty, administrative appointments, general education classes, honor guards, fatigue details, and routine medical care from being accomplished during prime time. To support prime time training and to fulfill other requirements, the battalion may employ the XYZ concept. Batteries are broken down into categories X, Y, and Z. Batteries in category X undergo full-time training, batteries in the Y status fulfill parent unit fatigue details, and batteries in the Z status train during prime time and back up the Y status units as required.

16-3. The Army Training System

a. The Army training system includes training in both institutions and units. It is geared to provide the highest degree of training with available resources. Training in institutions and training in units complement one another. Institutions provide highly trained individuals to units. The units mold section members into effective sections and units.

b. Unit training is classified as either *individual* or *collective*.

(1) *Individual training.* The primary emphasis in the cannon battery is on collective training. However, individual skills must be sharpened first. Individual self-study programs such as correspondence courses and training extension courses (TEC), are prepared at service schools but normally

are conducted in units. Two additional aspects of individual training common in cannon batteries are--

(a) *On-the-job training (OJT)*. When formal MOS training at institutions is not available, OJT may be used to qualify an individual for the award of an initial MOS or a secondary MOS.

(b) *Personal knowledge training*. This training is part of personal readiness for job performance. It consists of training in the rights and responsibilities of a soldier of the United States. Mandatory personal knowledge subjects include--

1. Military Justice (AR 350-212).
2. Code of Conduct (AR 350-30).
3. Survival, Evasion and Escape (AR 350-225).
4. The Geneva/Hague Conventions (AR 350-216).
5. Service benefits (allowances, reenlistment, and honorable discharge).
6. Policies in key areas (e.g., human relations and drug/alcohol abuse).

(2) *Collective training*. Collective training is designed to prepare teams, sections, and batteries to work as a group. Collective training should be structured to correct de-

ficiencies found during periodic unit evaluations.

16-4. Training Publications

A list of training publications available could fill several volumes. The following is a list of those keystone training publications that form the basis of any firing battery training program.

a. The Army Training and Evaluation Program (ARTEP) for the unit TOE.

b. FM 21-6, How to Prepare and Conduct Military Training.

c. FM 6-40-5, Modern Battlefield Cannon Gunnery.

d. TC 21-5-1, TMD 1, Training Management: An Overview.

e. TC 21-5-2, TMD 2, Performance-Oriented Training.

f. The user's manual for the unit's type of howitzer/gun.

g. Soldier's manuals and skill qualification tests (when published) for all unit MOS's.

The purpose of these publications will be discussed throughout this field manual, and their contents should be digested by all supervisors involved with training or management.

Section II. THE CANNON BATTERY TRAINING MANAGER

16-5. General

a. Training managers are responsible for the planning, organization, conduct, and evaluation of training. Training managers include the commanders who develop a training program or who provide training guidance to other commanders. Under present Army policy (AR 350-1), the battalion commander is the principal field artillery training manager. However, battery commanders and training officers of all units that develop training programs are also training managers. The battery commander's challenge is to use his limited resources in a manner that permits *efficient* and *effective* develop-

ment of his unit so it can successfully accomplish its mission.

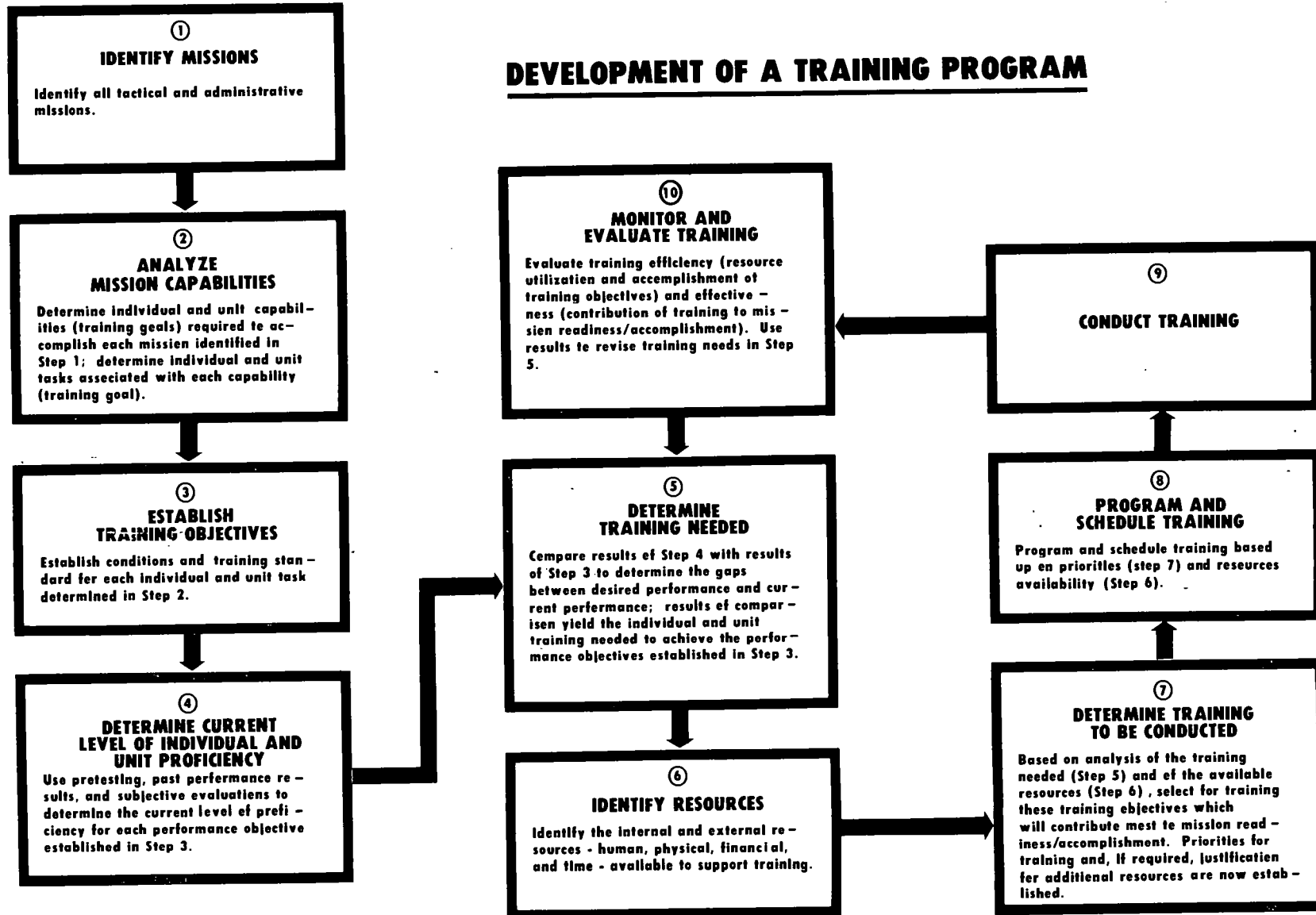
b. Table 16-1, reproduced from Training Circular 21-5-1, serves as an excellent guide for all training managers in the development of a training program. Paragraphs 16-6 through 16-10 are an overview of this approach.

16-6. How To Determine Where Your Unit Should Go in Training.

a. Steps ① through ③ in table 16-1 guide the battery commander toward establishing individual and unit performance objectives

TABLE 16-1

DEVELOPMENT OF A TRAINING PROGRAM



that, if attained, will insure his battery's ability to satisfactorily perform its assigned mission.

b. The procedures set forth in steps ① through ③ consist of identifying all tactical and administrative missions assigned to the battery, determining specific capabilities needed to accomplish each mission, and establishing performance objectives to meet each specific capability. The end result of this process is a statement of *WHERE YOUR UNIT SHOULD GO IN TRAINING*. Obviously, this is a time-consuming process.

c. ARTEP's are developed and published for each TOE. The ARTEP provides a systematic listing of performance objectives for specified levels of training. In effect, this listing will do steps ① through ③ for the battery commander for the tactical missions assigned in his TOE.

16-7. Determining Where Your Unit Is Now in Training

a. The next step (step ④) in the development process is for the battery commander to determine the current level of individual and unit proficiency in the PERFORMANCE OBJECTIVES established in step ③. The following data sources should be examined in making this determination:

- (1) Last formal ARTEP evaluation.
- (2) Unit readiness reports.
- (3) Field exercise after-action reports.
- (4) Weapons qualification records.
- (5) PCPT score cards.
- (6) MOS test/SQT results.
- (7) TPI results.
- (8) MET/COMET evaluations.
- (9) MAIT recommendations.

(10) Subjective evaluations by key personnel (XO, AXO, ISG, CFB) of the unit's ability to achieve ARTEP standards.

b. A new commander may lack confidence in the information received from the above data. To insure that his information is cur-

rent, the battery commander might want to conduct his own evaluation through diagnostic testing. The following evaluations can be used by the battery commander in conducting testing of the cannon battery elements:

(1) *Test for qualification of howitzer section chiefs (appendix D)*. Since the primary trainers in the cannon battery are the section chiefs, it is critical that the battery commander know the exact state of their training. This evaluation (test) allows the battery commander to determine this. The test is designed primarily to be administered to a section chief shortly after his arrival in a unit so that his weaknesses can be corrected before he is assigned to a section. This test can also be used for periodic evaluation of all section chiefs to insure that they maintain their proficiency.

(2) *Gunner's qualification test (appendix C)*. This test is designed primarily to identify weaknesses in the skills of personnel who perform the duties of gunner and assistant gunner. This test can also be used to evaluate the gunnery skills of howitzer section chiefs.

(3) *Section qualification tests (appendix B)*. Since it contains tests for all section members, this test allows the battery commander to determine the strengths and weaknesses of an entire howitzer section.

These tests do not require live ammunition and may be administered in local training areas.

(4) *Performance objectives established in ARTEP*. For those units for which an ARTEP has been published, the performance objectives in the Section Training/Evaluation Outlines portion of the ARTEP can be invaluable as a basis for diagnostic testing.

c. From pretesting, past performance results, and subjective evaluations, the battery commander should be able to determine where his battery is now in training.

16-8. Determining Training Needed

a. Determination of individual and unit training needs, step ⑤, is simply a comparison of the results of steps ③ and ④. In

other words--

WHERE YOUR UNIT SHOULD
GO IN TRAINING
(STEP ③)

MINUS

WHERE YOUR UNIT
IS NOW
(STEP ④)

EQUALS
TRAINING
NEEDED
(STEP ⑤)

For example, ARTEP 6-365 establishes the level of proficiency for emplacing the M109A1 howitzer as 30 seconds after stopping in position. While conducting station IV of the howitzer section evaluation, the battery commander might discover that five of his six howitzer sections cannot meet this standard, which indicates that training is needed in emplacing the howitzer.

b. When the commander finishes testing his personnel with all the performance objectives identified in the ARTEP, he will have identified all the tactical mission training he needs to conduct. He must then identify his available training resources to determine how much training can be accomplished.

16-9. Determining Resources Available

a. In the development of his training program, the battery commander must determine what resources are available to support his training and operational requirements (STEP ⑥). Resources can be categorized as follows:

(1) *Human resources*--the soldiers available for training and those available as trainers.

(2) *Physical resources*--the equipment, buildings, and training areas available for use in training.

(3) *Financial resources*--those funds allocated for conduct of training activities and for purchase of training aids/devices and/or other materials to be used for training.

(4) *Time*--Perhaps the most limited of all training resources.

b. Training resources must be carefully managed at all levels to insure efficient and effective use. Limited training resources should never be a scapegoat for ineffective training. With innovation, imagination, and proper management, battery commanders can always accomplish some effective training with their limited resources. The following are some tips on managing training resources in the cannon battery:

(1) *Utilize the 14.5-mm M31 trainer* for individual, section, and battery training. The M31 is an effective tool for developing teamwork and proficiency prior to live fire exercises. Training Circular 6-40-3 and TM 9-6920-221-13 should be referred to for information concerning firing battery procedures, firing range construction, training, ammunition, and maintenance.

(2) *Use the resources of your local Training Aids Service Office (TASO).* In addition to the motion pictures and related audio-visual aids indexed in DA Pamphlet 108-1, your local TASO can obtain training devices listed in DA Pamphlet 310-12. These devices include terrain boards, weapon mockups, enlarged firing charts, and realistic training rounds.

(3) *Make use of the Field Artillery School and other schools.* The Field Artillery School (FAS) provides the battery commander with a number of means of preparing and conducting professional training programs and classes. Among the resources available are the following:

(a) *Correspondence courses* provide professional development and special instruction in field artillery employment, tactics, techniques, organization, and weapon systems that are designed primarily for the officer and NCO.

(b) *MOS Guide* for Test Study, Reference, and Training is directed at MOS test

preparation and, consequently, MOSupgrading. The MOS guide provides the MOS test schedule and offers recommendations for assembling and maintaining an MOS study library and for conducting group study in the proper environment.

(c) *Class packets* for conducting formal classes consist of an instructor's lesson plan manuscript, student materials, and training aids needed for each class.

(d) *Programed texts* are used to supplement FAS resident instruction and are adaptable to performance-oriented training.

(e) *Video tapes* on a variety of subjects are used to support and reinforce FAS resident instruction.

(f) *Special items* published by the Field Artillery School are readily available. Copies of the Field Artillery Training Support Catalog and Field Artillery MOS Guide can be obtained by writing to the Field Artillery School.

(4) *Use the Training Extension Course (TEC) Program.* The TEC lessons are designed so that the individual soldier can use one of three approaches--audiovisual, audio only, or printed material. The lessons are targeted at the individual soldier or small groups. The TEC lessons are performance oriented and allow the soldier to take an active part in the presentation. With TEC, a unit learning center can be set up and tailored to the individual soldier's need for self-paced training in basic MOS-related skills.

(5) *Enforce a firm policy of prime time for training.* Many commanders have succeeded in marking off established periods of time devoted *exclusively* to training. This can be done on a daily, weekly, monthly, or quarterly basis (e.g., 4 hours each day, 2 days each week, or 1 month each quarter). Administrative absences can be limited to times other than prime training time. Utilization of block leave policies and the XYZ concept (para 16-2) help enforce prime time training by making better use of available training time.

(6) *Establish policies within the battery to maximize training time.* When authorized

by higher headquarters, the 1SG should assign entire *sections* to necessary duties instead of individuals from various sections. This promotes better use of training time and promotes section training. The 1SG should require that all section chiefs know exactly where every section member is at all times. The exemption of any individual from a duty roster should be examined very closely by the 1SG, as it aggravates the overall training and maintenance problems of the battery. The section chief must conscientiously attempt to utilize all bits of training time. When he has only a portion of his section for duty, it might be appropriate for them to clean protective masks, crew-served weapons, or section equipment or to work on individual TEC lessons. Trips to the post exchange, quartermaster sales, barbershop, etc. should be consolidated and planned so that they do not interfere with meaningful training or maintenance periods.

Only after carefully identifying the resources available can the commander determine which performance objectives he can accomplish. Expecting a unit to accomplish too much with too little resources is a common failing.

16-10. Determining Training To Be Conducted

a. Ideally, the battery commander would select for training *all* of the performance objectives determined in step ⑤. This will probably not be possible, so he should consider available resources and focus on the objectives that make the greatest contribution to accomplishment of the unit mission. He can do this by using the following three-phase process:

(1) *Establish training priorities.* The performance for which training is needed should be ranked in the order of their contribution to mission readiness. This listing must reflect guidance on priorities established by higher headquarters as well as judgment of the battery commander. The following might assist in establishing priorities:

(a) The battery commander should insure that his unit can accomplish the fundamental objectives (ARTEP level 2) before undertaking the more difficult performance objectives (level 1).

(b) Within a given ARTEP level the training objectives designated by an asterisk (*) should be accomplished before the other objectives. The asterisk designates *mandatory* training objectives for a given training level.

(2) *Estimate training resources.* The time, personnel, equipment, and training areas required to meet each of these performance objectives should be estimated.

(3) *Allocate available training resources.* The resources available to support training should be allocated in accordance with the priorities established in the first phase.

b. Here are three obvious benefits to be derived from this three-phase process.

(1) First, by having done his "homework," the battery commander can justify his needs for additional resources and can address the mission impact if his requests are denied.

(2) Second, the process will surface any misunderstandings as to the relative priorities for the unit's various tactical and administrative missions. If the emphasis is incorrect, it should become apparent in the response of higher headquarters to requests for support of training.

(3) Third, a higher headquarters needs a rational basis for allocating its training resources.

c. This process can be crucial in developing a training program. It can mean the difference between satisfaction and frustration when the commander is dealing with higher headquarters on matters related to training priorities and support.

16-11. Programing, Conducting, and Evaluating Training

a. Steps ⑧ through ⑩ in table 16-1 encompass programing, scheduling, con-

ducting, monitoring, and evaluating training. Coverage of preparing, conducting, and evaluating is expanded in chapter 17. However, an overview of these processes is necessary to demonstrate the entire training program development cycle.

b. In step ⑧, the battery commander programs and schedules the performance objectives selected for training in step ⑦. He programs these performance objectives on the basis of his determination of--

(1) When the required resources will become available (firing ranges, local training areas, ammunition, etc.).

(2) A logical sequence of conducting training from the easier to the more difficult tasks.

c. Failure to schedule and program carefully and well in advance can cause problems for both the trainer and the trainees. The principal documents used by the cannon battery to program and schedule training are the training forecast and the weekly training schedule. The training forecast is any type of calendar device that has enough space on which to indicate the performance objectives to be taught each day, the time to be devoted to each, and any training mandated by higher headquarters. It is the primary reference in the preparation of the weekly training schedule and normally covers a quarterly period. Long-range planning depicted in the training forecast is general in nature. However, within 1 month of conduct of the training, the forecast should be fairly specific (performance objective, time, and references should be indicated).

d. The quality of steps ① through ⑧ of this system will be clearly revealed during the conduct of training (STEP ⑨). The common focus of all previous steps is the *PERFORMANCE OBJECTIVE* selected for training. The *TASK*, *CONDITION*, and *STANDARD* of the performance objective define the conduct of training. Training should consist of problems and exercises that are designed to insure that personnel become capable of the performance objective.

e. Because the planning and conduct of training are based on a measurable and attainable performance objective, the monitoring and evaluation of training (STEP ⑩) are fairly easy. Performance testing is an *integral* part of the conduct of training. It provides the battery commander and his trainers continuous feedback on learning achieved. This feedback provides valuable information and data for revising the current training program and for future training activities. Specifically, if training standards for various performance objectives are

not met, those objectives require further emphasis. They become, in other words, input to Step ⑤ (training needed). Because of developments such as the assignment of new missions or priorities, changes in the unit equipment, and turnover of personnel, it is *mandatory* that the battery commander understands that the training process is continuous. Monitoring and evaluation--the last step in the process--is, in reality, a never-ending first step in the battery commander's efforts to plan and conduct effective training.

CHAPTER 17

TRAINING THE CANNON BATTERY

17-1. Performance-Oriented Training

a. Training should prepare battery personnel to do their jobs in combat. Therefore, the crucial first step in becoming an effective training manager or trainer is to recognize that *the purpose of training is preparation for performance*. Once this idea becomes ingrained in the thoughts of all battery trainers, training will become soldier oriented as opposed to trainer oriented.

b. The performance-oriented approach to training begins and ends with the *performance objective*. The information provided by a complete performance objective serves as a basis for training required as well as the evaluation (or test) of that training.

c. A proper objective can contribute greatly to evaluation of the training needed and the training conducted for a certain skill. A complete performance objective answers three questions--

(1) *Task*. What skill or knowledge is desired for the men undergoing training?

(2) *Condition*. What should exist for these men to demonstrate their skill or knowledge?

(3) *Standard*. How well, or to what standard, are the men expected to perform?

d. Since training is preparation for job performance, the *task*, *condition*, and *standard* set forth in each objective relate to the job requirements of the personnel undergoing the training. This insures that the trainees become capable of performing the tasks under the conditions and standards they will experience in their jobs in combat. As a result of this *learning by doing*, the trainer receives continuous feedback on the progress of those being trained and, consequently, on the efficiency of the training. Just as important, the soldiers being trained receive a steady flow of indicators on how well they are progressing.

e. Advantages of performance-oriented

training are--

(1) Performance objectives are clear and explicit. The trainers and those being trained know exactly what can be expected from the training. The performance objective is stated in measurable terms as opposed to such vague terms as "familiarity" and "working knowledge."

(2) Training resources are employed efficiently. Because performance objectives are written in precise, measurable terms, the training resources necessary to accomplish each performance objective can be allocated more objectively.

(3) Training is soldier oriented rather than trainer oriented. The training focus is toward soldier performance rather than a trainer's ability to present instruction.

(4) Soldiers learn better and faster. The soldier is actively involved in practicing a particular skill. He is encouraged as he accomplishes each objective. He learns complex skills by progressing from simple to complex tasks. The soldier's present ability to perform a task can be determined by use of the objective as a pretraining diagnostic test. The training session can then be aimed at the soldier's needs. This tailored training prevents a soldier from becoming bored by repeating something he already knows.

17-2. Developing Performance Objectives

a. The key to effective performance-oriented training is a definitive training objective. Battery commanders can begin moving their training activities in the performance-oriented direction by establishing mission-essential individual and collective performance objectives. The ARTEP published for each TOE provides a listing of performance objectives for each section of the battery and for the cannon battery as a whole.

b. FM 21-6, How to Prepare and Conduct Military Training, explains the *backward*

planning a trainer can use to insure that he prepares and conducts training in the most effective and efficient manner. This section presents some additional ideas to help the battery commander and his subordinate trainers conduct individual and collective training. The discussion in the next two paragraphs is geared toward the training of the cannon battery, excluding the fire direction center and forward observers. The training of these personnel is covered in FM 6-40-5.

17-3. Individual Training

a. The section chief is the primary trainer in the field artillery cannon battery. The battery commander must be assured that an NCO has the appropriate technical expertise before assigning him as a section chief. Here are some ways to determine an NCO's ability:

(1) For howitzer section chiefs there is the Test for the Qualification of Howitzer Section Chiefs (appendix D). This test can be administered in a 4-hour period and will clearly identify those areas in which the NCO is weak or deficient. Having identified any weaknesses, the executive officer/chief of firing battery can, if necessary, set up a training program to teach the needed skills. Upon demonstrating that he has learned the skills, the NCO can be assigned to a howitzer section.

(2) Evaluating a potential ammunition section chief is more complex. Since the ammunition sergeant's MOS is 13B40, he should be qualified as a howitzer section chief according to the above guidelines. However, he must also be proficient in ammunition vehicle operation. Therefore, he must demonstrate his ability to perform the tasks listed in table 18-4 of this manual to insure that he can supervise ammunition vehicle operators. DA Pamphlet 10-76-8PT, Preparing Ammunition Request and Turn-In Forms, is a useful programmed text that will help the ammunition sergeant learn the administrative portion of his duty assignment.

(3) The evaluation and orientation of the battery motor sergeant, supply sergeant, and communications sergeant are best accomplished by the battalion staff NCO

or officer with whom the section chief will be coordinating in day-to-day activities. For example, the battalion motor sergeant would be an appropriate individual to evaluate a new battery motor sergeant and orient him on his duties and local operating procedures. Likewise, the battalion supply sergeant and the battalion communications sergeant would evaluate and orient a battery supply sergeant and a battery communications sergeant. After the prospective battery section chief spends 3 to 5 days with the appropriate battalion staff section, he should be ready to accept responsibility for his section. During this time, his battalion counterpart should have identified any weaknesses in the individual's technical ability and taken steps to correct them.

b. A system must be established to insure that all NCO's maintain their proficiency in their job skills and prepare themselves for the next higher grade. One of the best methods to increase the MOS proficiency of a section chief and to help him advance in his career is the correspondence course program. The various service schools have individual and/or group study programs to assist an NCO in maintaining proficiency in his MOS. Table 17-1 is a list of typical cannon battery supervisory positions and correspondence courses appropriate to each position.

c. The mission of the individuals in the battery headquarters section (cooks, mechanics, clerks, etc.) is day-to-day support of the entire cannon battery. Therefore, these personnel do not normally participate in the collective training except for battery-level field exercises and mandatory personal knowledge classes. It is more practicable to set up an OJT program for these individuals utilizing the correspondence/OJT courses offered by the various service schools. These courses can be used to qualify personnel in an MOS for which they have not been previously trained and also to maintain the MOS proficiency of school-trained personnel. Table 17-2 is a list of typical cannon battery headquarters MOS's for which training programs may be necessary and the correspondence/OJT course available for each MOS.

Table 17-1. Correspondence Courses for Cannon Battery Supervisory Personnel.

DUTY POSITION	COURSE TITLE AND GRADE REQUIREMENT	ADDRESS—APPLICATION OR CATALOG
Chief of firing battery or gunnery sergeant	Field Artillery Cannon NCO Advanced (E6 or E7) Cannon Firing Battery (any grade).	Commandant US Army Field Artillery School ATTN: ATSF-AW-AP Fort Sill, OK 73503
Howitzer chief of section or ammo sergeant	Cannon Firing Battery (any grade) Field Artillery Cannon NCO Basic (E4 or E5) Field Artillery Cannon NCO Advanced (E6 or E7).	
Comm chief	Field Artillery Communications (any grade) Tactical Electronic Equipment Maintenance NCO Basic (E4 or E5, MOS 31G or 31D) Tactical Electronic Equipment Maintenance NCO Advanced (E6 or E7, MOS 31G or 31D).	
Reconnaissance sergeant or chief computer	Cannon Fire Direction (any grade) Forward Observation (any grade) Field Artillery Cannon NCO Basic (E4 or E5) Field Artillery Cannon NCO Advanced (E6 or E7).	
Motor sergeant	Mechanical Maintenance NCO Basic, E40 (E4 or E5) Mechanical Maintenance NCO Advanced, E42 (E6 or E7)	Commander US Army Ordnance Center and School ATTN: ATSF-TER-O Aberdeen Proving Ground, MD 21005
CBR NCO	Unit CBR NCO Correspondence Course (E5 or above).	
Supply sergeant	Supply NCO Basic Correspondence Course (E4 or E5) Phase 1, USAQMS NCO Advanced Correspondence Course (E6 or E7).	Commandant US Army Quartermaster School ATTN: AWTSD (A&P) Fort Lee, VA 23801
Mess steward or first cook	Food Service NCO Basic Correspondence Course Phase I, USAQMS NCO Advanced Correspondence Course (E6 or E7).	
Comm chief (31G)	Tactical Electronic Equipment Maintenance NCO Basic Course (E4 or E5) Tactical Electronic Equipment Maintenance NCO Advanced Course (E6 or E7).	Commandant US Army Signal School ATTN: DAWTS Fort Gordon, GA 30905
Comm Chief (36K)	Wire, Antenna, and Central Office Management NCO Basic Course (E4 or E5) Wire, Antenna, and Central Office Management NCO Advanced Course (E6 or E7).	
First sergeant	Special Correspondence Course for Company Administrative Personnel (any grade)	Commander US Army Institute of Administration ATTN: AWTSD Fort Benjamin Harrison, IN 46249

Table 17-2. Correspondence/OJT Programs for Battery Headquarters Personnel.

DUTY POSITION	COURSE TITLE AND GRADE REQUIREMENT	ADDRESS—APPLICATION OR CATALOG
Battery clerk	Special Correspondence Course for Unit Clerks, MOS 75B (any grade) Special correspondence Course for Company Administration (AG—OMP) NCO Basic Correspondence Course (E4 or E5)	Commander US Army Institute of Administration ATTN: AWTSD Fort Benjamin Harrison, IN 46249
Field wireman	Field Wireman Correspondence Course (E2 and above)	Commandant US Army Signal School ATTN: DAWTS Fort Gordon, GA 30905
Unit supply specialist	Unit and Organizational Supply Basic Correspondence Course (E2 and above) Unit and Organization Maintenance, Repair Parts Supply, and Storage Correspondence Course (E2 and above).	Commandant US Army Quartermaster School ATTN: AWTSD (A&P) Fort Lee, VA 23801
Armorer	Small Arms Maintenance Correspondence Course I (E2 and above) Small Arms Maintenance Correspondence Course II (E2 and above).	Commandant US Army Quartermaster School ATTN: AWTSD (A&P) Fort Lee, VA 23801
Cook	Dining Facility Operations Correspondence Course (E2 and above) Food Service Administration and Field Operations Correspondence Course (E2 and above).	

Notes.

1. Correspondence/OJT programs for maintenance section personnel are listed in table 18-1.
2. Battery headquarters personnel in grade E4 who are MOS qualified should also consider enrolling in the NCO basic courses listed in table 17-1.

d. This program is soldier oriented. The individual can move at his own pace. The supervisor assists in and monitors the instruction rather than controlling it. The individual is forced to become proficient in all tasks required of his MOS rather than just those he is presently performing in his day-to-day work. This program increases all aspects of MOS proficiency and results in improved battery duty performance and MOS test results. In addition, AR 600-200 (chapter 7) provides that promotion points will be allocated for credit hours completed. Thus, the individual and the unit benefit from this individual training program.

e. If an individual's study program is mission related, the unit commanders should encourage him and provide maximum assistance, to include obtaining study materials and providing time and facilities for study. The following are some ways an individual training program utilizing correspondence courses might be enhanced. The commander should--

- (1) Obtain several copies of the correspondence course catalogs of service schools that offer courses applicable to his firing battery MOS's. He can obtain these by writing to the addresses listed in tables 17-1, 17-2, and 18-1.

(2) The battery commander/training officer should keep a progress record of all individuals in the battery enrolled in a correspondence/OJT program; the first sergeant should keep a progress record of all NCO's enrolled in a correspondence course; the section chief should keep a progress record of all section members enrolled in a correspondence/OJT program. By maintaining these records, the battery leaders show their interest in individual progress and have a basis for counseling and encouraging the individual. Table 17-3 is an example of a format that can be used by the battery commander, training officer, or section chief. It can be changed to suit the tastes of the individual battery commander. One chart can be used for all personnel in correspondence courses. The dates entered indicate when each subcourse was completed. Keeping these data current will be no problem, since the service schools send the battery commander a computer-printed notification after completion of each subcourse and a certificate of completion (or a diploma) at the end of an entire course.

(3) The battery commander should provide a place for study, maintain a complete MOS library, and recognize achievement.

(4) Many battery headquarters personnel can work on their courses during slack time at their jobs. A room should be established, however, where personnel can study after duty hours in the proper atmosphere. For those batteries that do not have the facilities for this, an MOS study room containing an MOS library and TEC facilities might be feasible at battalion level for use by all personnel.

(5) Completion of a correspondence course should be treated in the same manner as graduation from a service school. The certificate of completion or diploma should be awarded in an appropriate award ceremony, and the approval of a 3- or 4-day pass might also be warranted.

(6) A battery commander can best assist an individual in a correspondence program by providing time during duty hours

for him to work on his courses. This time should be devoted exclusively to individual MOS proficiency. A very appropriate time would be when a battery is in the Y status (fulfilling parent unit fatigue details) of an XYZ prime time for training program. Most of the battery personnel are performing other tasks, so collective training is impossible. A firing battery might also schedule 4 hours per week as a "professional period" during prime time for training. During these times of MOS study, the following groups might work together in individual or group study:

(a) Howitzer section chiefs, gunners, chief computer, reconnaissance sergeants, and ammunition sergeant working on individual correspondence courses under the supervision of the chief of firing battery and the gunnery sergeant.

(b) All 13B's, grades E4 and below, working under the supervision of the XO, AXO or chief of firing battery. The Soldier's Manual can be used as a basis for performance-oriented training drills in preparation for the annual skill qualification test (SQT). Training extension courses (TEC) can also be used effectively to refresh the individual soldier's knowledge and polish the basic skills associated with his MOS.

(c) All 13E's, grades E4 and below, working under the supervision of the XO, AXO or FO. The Soldier's Manual and TEC can also be used as a basis for this program.

(d) Battery headquarters personnel working on correspondence courses under the supervision of their section chiefs.

f. There is a certain amount of individual knowledge that *all* soldiers *must* have regardless of rank or MOS. Personal knowledge subjects are specified by AR 350-1 and listed in paragraph 16-3 of this manual. The regulations covering these subjects are fairly explicit; however, the battery commander should realize the following points in scheduling instruction in personal knowledge subjects:

(1) The regulation covering military justice training (AR 350-212) is the only regulation covering mandatory personal knowl-

Table 17-3. Correspondence/OJT Program Progress Record.

[illegible]

edge that specifies an exact course of instruction. Commanders must take this into account when programing training and must normally program military justice training for those personnel required to attend once every 6 months.

(2) The other regulations covering mandatory personal knowledge subjects (i.e., AR 350-30, 350-216, and 350-225) do not specify length of instruction or frequency of instruction. They simply state those areas in which the individual soldier must have a working knowledge. A policy of scheduling these subjects on the training schedule every 3 to 6 months could waste valuable training time if most of the battery already understands these subjects. Some alternatives are--

(a) Diagnostic testing of battery personnel every 3 to 6 months on these mandatory subjects and remedial classes for those who are deficient.

(b) Integration of these mandatory subjects into, for instance, a battery commander's weekly 1-hour seminar.

(c) Permanently posting copies of lesson plans or fact sheets on these personal knowledge subjects on the battery bulletin board and then utilizing these as a basis for individual questioning during in-ranks inspections, guard mounts, soldier-of-the-month boards, and promotion boards. This gets the entire chain of command involved with these subjects constantly.

17-4. Collective Training

a. Collective training is designed to prepare crews, teams, squads, and so forth to accomplish tasks required by the group. In the cannon battery, collective training principally involves the howitzer sections, ammunition section, fire direction center, forward observer sections, and the cannon battery as a whole.

b. Guidance on the training of battery fire direction centers and forward observer sections is given in FM 6-40-5, Modern Battlefield Gunnery Techniques. Paragraph 17-7 of this manual gives some general guidelines on the conduct of battery-level collective training. The discussion in the following two

paragraphs focuses on the collective training of howitzer sections and ammunition sections.

17-5. Training Howitzer Sections

a. The objectives of howitzer section training are to--

(1) Train individuals in their principal duties.

(2) Train the section as a team.

(3) Cross-train individuals in the various duties with the section.

The howitzer section chiefs are the principal trainers in the cannon battery during the conduct of howitzer section training. By insuring that all howitzer section chiefs are qualified in their job skills, the battery commander takes a big first step in developing effective section training.

b. Even though AR 350-1 does not require any formal record of individual or collective training in the firing battery, some sort of system should be established to record the training progress of each individual and each howitzer section in the firing battery. Each howitzer section chief should have a notebook in which he keeps an informal daily record of training conducted, individuals present for instruction, performance objectives accomplished, deficient areas noted, and any other remarks pertaining to the training of his section. These records should be examined regularly by the XO and CFB to help them evaluate training and program future activities.

c. The executive officer and chief of firing battery should keep their own records of the training progress of the firing battery as a whole. This record might be in the form of a weekly handwritten memorandum for record that specifies performance objectives accomplished by the firing battery, noted improvements and weak points, and any remarks useful in programing future training. A handy place for these remarks is on the back of the field copy of the battery weekly training schedule. With the remarks placed here, they are available to anyone concerned with programing training and also serve as a historical record of *lessons learned* for a new XO or

CFB coming into the unit.

d. Section drill (*cannoneers' hop*) serves some usefulness in training a howitzer section; however, training based solely on section drill will quickly become monotonous and boring. A good howitzer section training program incorporates many training tools. Some of the available tools are--

- (1) Section drill as shown in the appropriate field manual or user's manual.
- (2) Gunner's test (app C).
- (3) Training extension courses.
- (4) Howitzer section evaluation (app B).
- (5) Army training and evaluation program.

Howitzer section training should consist primarily of controlled practice of a task. Most of the training tools listed above are already in the performance-oriented training format (task, condition, and standard), so the training job is simplified.

e. Training is normally conducted in three phases--

- (1) During phase I, the section chief states the performance objective and demonstrates how the task is properly performed.
- (2) In phase II, the soldier practices the tasks. His goal during this phase is to meet the standards stated by the section chief in phase I.
- (3) Finally, in phase III, the soldiers are tested while actually performing the tasks. The results will show whether or not the soldier meets the task standard in each performance objective.

f. Let's look at *HOW* the training tools mentioned above can be incorporated into an effective howitzer section training program.

- (1) Most training sessions for a howitzer section begin with preparing the piece for firing, and end with preparing the piece for traveling. The techniques of section drill can be used for attaining the proficiency of the section in preparing for firing and travel-

ing in a garrison environment. Each training session in which the howitzer is used can begin with a timed exercise in which each howitzer section prepares its piece for firing. In this exercise each section available for training would load its equipment in the section vehicle and stand by in a waiting area. Upon order of the XO/CFB, the gun guide would lead the howitzer to a predetermined position. The XO/CFB would time the occupation from the moment the howitzer stopped in position until it was prepared to fire. Since the sections are timed individually, the spotlight is placed on one section at a time and a competitive spirit is fostered. The occupation should be video-taped, if possible, and the tape should be used in the critique. Of course, the XO/CFB would have to establish certain standards, such as the amount of equipment to be carried with the howitzer, the time penalties for procedural errors and inaccuracies, and the initial deflection to the aiming circle.

(2) A similar exercise, in preparing the howitzer for travel, can be included following the training session. The howitzer sections can be timed individually or as a group from the command *MARCH ORDER* until the report *NUMBER (so-and-so) IN ORDER*. The XO/CFB can foster the competition in many ways. Publicity can be given to the competition; e.g., a poster can be placed in the battery headquarters displaying the record times and/or the six fastest times in preparing for firing and traveling. Awards can be made for record times. The XO/CFB can put extra complications into the competition by rotating the duties of section personnel, having the section chief lay his own howitzer, etc., in order to enhance cross-training. Two cautions should be pointed out to those batteries considering this approach.

(a) Safety must be emphasized continuously. Just because the section is trying to beat the clock does not mean that unsafe practices can be tolerated.

(b) If it becomes obvious that the howitzer sections are proceeding in a disorganized manner, the competition should be terminated and a more formal section drill (*cannoneers' hop*) should be conducted until minimum proficiency standards are met.

In summary, the routine actions of preparing for a training session can be used to get section personnel charged up at the beginning of the training session and, more important, help them to become thoroughly proficient in their duties during preparation for firing and travel.

g. The tasks specified in the Test for the Qualification of Gunners (appendix C) can be used to establish and maintain the proficiency of the individuals in the howitzer sections in a garrison-type environment. These tasks are a good starting point for those units in which individual skills need to be sharpened before section members are drilled as a group. Even though the tasks specified are most appropriate for those personnel who perform the duties of gunner or assistant gunner, all cannoneers *should* undergo this training. This training will help all cannoneers improve their MOS skills and help identify those soldiers who are most proficient in these duties. Since the howitzer is the teaching vehicle for all tasks specified in the gunner's test, the procedures outlined in the preceding subparagraphs can be used at the beginning and end of the training session. The XO/CFB can use the gunner's test as the basis for a 5-day training cycle for his howitzer section personnel. For the first 4 days (one 4-hour period each day) the chiefs of section would supervise the controlled practice of approximately 25 percent of the tasks specified in the gunner's test. This controlled practice would be in the three-phase format previously discussed. A suggested breakdown is shown in table 17-4.

(1) The training can be organized in several different ways. Each section chief may train his own personnel on all tasks, each section chief may be responsible for one task and section personnel rotated between section chiefs (round-robin technique), or a combination of these approaches may be used. There are obvious benefits in keeping a section together; however, in some cases, having section personnel move around to

another howitzer and hear another voice might be good.

(2) The benefits gained from training in a local training area rather than in the battalion area or motor pool are obvious. There will be fewer distractions and soldiers and trainers alike can concentrate on the job at hand.

(3) In this and all other phases of training, careful consideration must be given to the selection of an individual to perform as an acting chief of section when the chief of section is not present for duty. The acting chief of section should be given very definite training objectives that he is capable of meeting.

(4) This 4-day cycle does not have to take place in 4 consecutive days. For variety, instruction in general military subjects might be given on alternate training days. Such subjects may include--

- (a) Performance of first aid.
- (b) Protection from CBR attack.
- (c) Headspace and timing of the .50 caliber machinegun.
- (d) Disassembly and assembly of the M60 machinegun.
- (e) Disassembly and assembly of the M16A1 rifle.
- (f) Performance of crater analysis.
- (g) Camouflage of equipment.
- (h) Construction of field fortifications.
- (i) Defense against air attack.
- (j) Reporting of intelligence information.
- (k) Establishment and operation of wire communications.
- (l) Emergency destruction of equipment.

TEC programs are being developed for all the individual skills evaluated in the gunner's test. If an individual misses a day of instruction or needs more reinforcement of

Table 17-4. Four-Day Individual Training Program.

DAY	SUBJECT	TASK NO
1	Reciprocal laying with panoramic telescope and aiming circle.	2
	Alining the collimator.	3
	Alining the aiming posts.	4
	Measuring site to crest.	5
2	Indirect laying, deflection only.	9
	Correcting for displacement with aiming posts.	10
	Correcting for displacement with collimator.	11
	Boresighting the howitzer.	8
3	Direct laying, panoramic telescope.	1
	Performing micrometer test on gunner's quadrant.	6
	Performing end-for-end test on gunner's quadrant.	7
4	Laying for quadrant with the elevation scale.	12
	Laying for quadrant with the gunner's quadrant.	13
	Breechblock disassembly.	14
	Breechblock assembly.	15
	Howitzer lubrication.	16

a task, he can study the appropriate TEC lesson to remedy his shortcomings. These programs can also be used effectively to supplement training on those days when the present-for-training strength of the firing battery prohibits the centralized approach.

(5) The fifth day in this training cycle can be used for the formal administration of the gunner's test. This test can be used as a motivational factor through the four preparatory training days, especially if added incentives are built into the competition by the chain of command. A marksmanship medal can be awarded an individual who qualifies as an expert, a first-class, or a second-class gunner. To provide a completely impartial evaluation, the formal administration of the test should be conducted by the battalion staff if at all possible.

In summary, the test for the qualification of gunners can be used as a competitive tool to establish and/or maintain individual proficiency before proceeding to more advanced collective training.

h. The Howitzer Section Evaluation (appendix C) should be used as the next highlight of training.

(1) The section evaluation is designed to encourage teamwork within the section and to strengthen the section chief's ability to operate with or independent of the battery organization. Emphasis is placed on the section's speed, accuracy, and flexibility in performing the firing battery mission. The

evaluation involves six stations and does not require any ammunition. Stations IV and V must be conducted in a local training area. Consider the following before planning the use of this evaluation:

(a) The tasks evaluated in station II are very similar to tasks tested in the gunner's test. Station III is an evaluation of individual general knowledge and maintenance. (Note. Maintenance training is covered in chapter 18.) Therefore, the majority of training time should be spent practicing the six collective tasks of stations IV and V.

(b) The section chief should be given a great amount of flexibility in preparing his section for this evaluation. He should understand that this is his show and that the heat is on him to get his section prepared. Every effort should be made to *give the section chief time* to train his section and to have all his personnel available to him during training sessions.

(c) The XO/CFB has a definite role in the preparatory training for the section evaluation. The XO/CFB should observe and advise the section chiefs of shortcomings in their sections and make suggestions for improvement. He can help pace the training by planning and conducting intermediate evaluations of the sections according to the checklists in the howitzer evaluation. Table 17-5 is a sample progression that he might use.

(2) Table 17-5 shows the XO/CFB making continuous evaluations of training as it is being conducted and providing immediate feedback to the chief of section. The XO/CFB should set high standards in his evaluations. A good technique is to invite an outsider to conduct one of the intermediate evaluations. The battery first sergeant, an assistant S3 officer, or even an executive officer or chief of firing battery from a sister unit might see procedural errors that have gone unnoticed.

(3) The logical completion of this training cycle is the formal administration of the howitzer section evaluation. To insure objectivity, this evaluation should be conducted by the battalion or higher headquarters staff. Appropriate rewards should be established

for the attainment of high scores. The XO/CFB might consider assigning the high-scoring section in the battery as *base piece*.

In summary, the Howitzer Section Evaluation is not just a test, it is also a tool available to the battery commander for training his howitzer sections.

The Test for the Qualification of Gunners and Howitzer Section Evaluation are established to support training in a garrison type environment without the necessity for any live firing ranges or ammunition. The standards used in these two evaluations are based on the standards published in existing ARTEP. Obviously, a more thorough evaluation could be made of a howitzer section at a major training area firing live ammunition or firing the M31 FA trainer if live ammunition is not available. (See page 24, TC 6-40-3.)

i. The ARTEP should be used as the basis for any howitzer section evaluation incorporating the actual firing of ammunition.

(1) A scenario and checklists can easily be established similar to those shown in the Howitzer Section Evaluation. The standards of performance can be extracted directly from the appropriate ARTEP. The section chief should insure that his section is also proficient in the tasks listed below before it engages in a live firing evaluation.

- (a) Loading a round during firing.
- (b) Disposing of unfired powder increments.
- (c) Preparing fuze setters for use.
- (d) Preparing ammunition for firing.
- (e) Priming the weapon (if appropriate).
- (f) Preparing unfired ammunition for travel.

Table 17-5. Sample Training Progression in Preparation for Howitzer Section Evaluation.

DAY	TIME (HRS)	ACTIVITY
1	4	Training under control of section chief.
2	4	XO/CFB evaluates all sections on gun guide procedures, deliberate occupation, and indirect laying. Sections not being evaluated train under control of section chief.
3		XO/CFB evaluates all sections on deliberate occupation and direct laying. Sections not being evaluated train under control of section chief.
4	4	XO/CFB evaluates all sections on deliberate occupation, hasty displacement and hasty occupation. Sections not being evaluated train under control of section chief.
5	4	XO/CFB evaluates all sections on deliberate occupation, hasty displacement, hasty occupation, and 6,400-mil mission. Sections not being evaluated train under control of section chief.
6	4	XO/AXO/CFB administers practice evaluation (stations I to VI) to sections 1 through 3. Sections 4 through 6 train under control of section chief.
7	4	XO/AXO/CFB administers practice evaluation (stations I to VI) to sections 4 through 6. Sections 1 through 3 train under control of section chief.

(g) Taking immediate action required after a misfire.

(h) Removing a rammed projectile.

(i) Commanding *CHECK FIRING* when an unsafe condition is recognized.

(j) Servicing ammunition.

(k) Loading ammunition on the section vehicle.

(l) Transporting ammunition on section vehicles.

(2) A howitzer section that has successfully completed the Howitzer Section Evaluation and the tasks listed above should be well prepared to undertake a live firing section evaluation. A live firing evaluation is a fitting climax to *any* howitzer section training program.

Here's a recap of the ideas suggested in this paragraph for training howitzer sections:

- Section drill has limited value.
- Timed exercises in howitzer occupation can help to create proficiency.
- The Test for the Qualification of Gunners can be employed as the initial highlight of garrison section training.
- The Howitzer Section Evaluation is the second highlight of garrison section training.
- A live firing section evaluation based on the standards published in the ARTEP would be a fitting climax to any howitzer section training program.

17-6. Training An Ammunition Section

a. The primary mission of the battery ammunition section is the transportation and delivery of ammunition. The training of this section should dwell heavily on the tasks related to this mission; i.e., driving, ammunition handling and storage, maintenance of ammunition and ammunition vehicles, map reading, RTO procedures, etc. The ammunition section chief should initially be concerned with training all of his section personnel to become proficient wheeled vehicle drivers. Since driving is such a major portion of the ammunition section mission, the battery commander should be very hesitant to assign an individual to the ammunition section who is incapable of, or unmotivated toward, becoming a qualified driver. Paragraph 18-6 offers guidance on operator training and supervision, and should be referred to by the XO, CFB, and ammunition section chief in setting up this very important first part of the ammunition section training program.

b. The executive officer must bear in mind that the ammunition section members must maintain proficiency in their cannon duties. Ammunition personnel should train with the cannon section personnel in preparation for the gunner's test. After this training with a cannon section, the ammunition sergeant can train his section independently while the cannon sections prepare for the Howitzer Section Evaluation. The ammunition section should receive instruction in advanced driving techniques and field artillery ammunition subjects. Table 17-6 is a list of suggested tasks for *advanced* driver training.

c. Since a battery ammunition section normally has only three to nine personnel, TEC lessons presently under development on field artillery ammunition will be a very effective and appropriate teaching vehicle for the ammunition section.

d. During field training, each member of the ammunition section might be assigned to a cannon section. After performing his ammunition section duties, he could perform the duties of a cannoneer to assist in

maintaining his MOS proficiency. Whenever a cannon section chief is absent from duty, the ammunition section chief could serve as acting chief of section in order to help maintain his proficiency.

17-7. Battery-Level Training Techniques

All too often a battery commander takes his entire battery to the field for a live firing exercise as soon as he feels each individual section is proficient in its duties. Then he discovers that his radio equipment doesn't work properly, that the reconnaissance party is disorganized, that priorities for occupation have not been established, that the first sergeant does not know how to organize for defense, or a myriad of other problems. Then 100 soldiers stand around watching "quick-fix" corrections being made. The battery commander *must* keep in mind that a field training exercise (FTX) is not the sole method of developing battery teamwork. When men, training areas, ammunition, and time are limited, the battery commander *must* select the tactical exercise that *best* accomplishes the immediate training objective with the *least* expenditure of resources. Throughout this manual, training tips are given for teaching certain field artillery skills and procedures. This paragraph presents an overview of a suggested *building block* technique for molding the various battery sections into a cannon battery team.

a. The terrain exercise, or tactical exercise without troops (TEWT), is a tried method of training. During this exercise, the disposition and/or movement of simulated troops or equipment is planned and discussed at a particular location. A TEWT involves nothing more than a leader taking his subordinates to a predetermined tactical location and discussing application of various tactical principles. Some examples of the application of this technique are--

(1) A TEWT involving the battery commander accompanied by the XO, AXO, 1SG, CFB, GSG and the communications chief would be the first step in a battery tactical exercise. The battery commander would go with these subordinates to different tenta-

Table 17-6. Advanced Driving Instruction.

TASK	REFERENCES
Load and lash cargo in vehicle.	TM 21-300, and 55-310; FM 21-305
Utilize correct procedures for hauling dangerous cargo	TM 21-300, 55-310, and 9-1300-206; FM 213-5
Utilize correct method of winch operations.	Operator's manual, FM 20-22.
Use field expedient methods for self-recovery.	Operator's manual, FM 20-22.
Drive vehicle in convoy.	TM 21-300, 55-310, and 55-312; FM 21-305
Drive vehicle on cross-country roads.	FM 21-305
Drive vehicle on freeway.	FM 21-305

tive firing positions. An informal, two-way, question-and-answer discussion of such things as positioning of howitzers, organization of the position area, installation of communications, entrance routes, placement of the aiming circle, location of outposts and listening posts, and employment of crew-served weapons, would surface problem areas and resolve them before going any further in training. The battery commander does not have to make meticulous preparations for the TEWT, but he must have a firm idea of the tactical principles of reconnaissance, selection, and occupation of position. In a separate TEWT, the battery commander and the battery FO's could go to various observation posts to discuss selection of locations for observation posts, terrain associations, etc.

(2) A TEWT can be an educational experience for all persons involved, and it permits the battery commander to spend a great deal more time with the battery leaders than would be possible if the entire unit were present.

b. The second step in this recommended training sequence is a command post exercise (CPX). A CPX is a tactical exercise for the command and communications personnel of a unit. The purpose of a CPX is to per-

mit leaders at all levels to go through the command and control procedures involved in a firing battery operation in the same manner as they would in an FTX or in combat. It is recommended that the following personnel take part in a firing battery CPX:

- (1) The BC and 1SG with vehicle.
- (2) The XO or CFB/GSG with vehicle.
- (3) The entire FO section with all TOE equipment.
- (4) The entire FDC and BOC with all TOE equipment.
- (5) The entire communications section with all TOE equipment.

The battery commander should develop a scenario that calls for the initiation of fire missions, displacement, and reports similar to those listed in the appropriate ARTEP. The beauty of a CPX is that it can be accomplished in about one-third of the time it would take for a full-scale exercise. The CPX will help surface procedural errors, communication problems, and unfamiliarity with the battery field SOP. A fast-moving scenario is the key to a good CPX. Actions should be initiated according to how the situations are presented and how the different sections react. The battery commander may interrupt

at times to offer a critique. The duration of the exercise depends on its value in the eyes of the battery commander. At the conclusion of the CPX all participants should gather to discuss the actions in the CPX.

c. Rehearsals for the reconnaissance party is the next logical step in our sequence. The training and organization of the reconnaissance party is discussed in chapter 3. The battery commander should make the rehearsal as realistic as possible--as though it were an actual reconnaissance. Rehearsals should include preparation of howitzer positions, selection of alternate and supplementary positions, selection of track plans, emplacement of route markers, and guiding simulated howitzers into position. These rehearsals can be the key to a smooth occupation during all subsequent tactical exercises. While the battery commander is conducting rehearsals for the reconnaissance party, the XO and CFB/GSG might profit by conducting erection drills for the remainder of the battery. Such drills can help save valuable time and prevent damage to equipment during future field exercises. These drills also provide the XO/CFB/GSG with a means of insuring that all components of stored equipment are present and serviceable. These drills might include erection of such things as--

- (1) Tents.
- (2) Camouflage nets.
- (3) Howitzer section installations.
- (4) The RC-292 antenna.
- (5) Generator sets.
- (6) A portable latrine.
- (7) Immersion heaters.

These drills can be interesting training exercises, especially when competition is built in by the XO/CFB/GSG.

d. The M31 (14.5-mm) field artillery trainer can be used effectively in the initial phases of the combined training of weapons crews, fire direction personnel, and forward observers. Together with specially designed FADAC tapes and graphical equipment, the

M31 system allows realistic fire direction center computations, good ground observation practice, and total system integration at nominal cost. By using the M31 at this point in the training sequence, the battery can make a preliminary evaluation of the performance of the firing battery team (FO-FDC-howitzer) and correct faults without utilizing expensive service ammunition (see TC 6-40-3 on the employment of the M31).

e. The final preparatory step in our sequence leading up to a firing battery FTX is a CPX with base piece. The CPX with base piece is a live firing exercise involving only one howitzer section. The following personnel participate in addition to those discussed in paragraph 17-7b:

- (1) Base piece howitzer section.
- (2) One gun guide from each non-participating howitzer section.
- (3) Support personnel (maintenance, ammunition, supply, mess) as designated by the battery commander. A complete real-time scenario can be established for this CPX with base piece directly from the ARTEP. The unit can then undergo a mini-FTX of all missions established in the ARTEP while using only about 50 percent of the ammunition required for a full-scale firing battery ARTEP. Most of the same problems that would have occurred in a full FTX will surface.

f. A full-scale firing battery FTX should be the highlight of any battery-level training sequence.

(1) A well-conducted field exercise offers the battery commander two well-defined products. First, it demonstrates the ability of the entire unit to perform under simulated combat conditions and identifies training requirements for future training. Second, it offers a test of those skills and techniques his previous exercises have taught.

(2) Successful conduct of a field exercise depends upon a complete scenario based on the ARTEP and good control by battery leaders or higher headquarters.

(3) The FTX should be conducted

under complete tactical conditions so that the commander will not waste his time and the time of his men. The commander should allow the battery headquarters to take full part in the tactical play. *All* TOE equipment should be taken to the field. This exercise is one of the best vehicles the commander has at his disposal for practicing the many aspects of the unit field SOP.

(4) It is nearly impossible to keep all members of the battery gainfully employed during the conduct of an FTX; therefore, the battery commander must give consideration to concurrent *slack time* training before going out on an FTX. The commander should give priority to those subjects that cannot be thoroughly learned in a garrison-type environment, such as setting fuzes, storage of ammunition, recovery of vehicles, construction of field fortifications and cross-country driving. Other suggestions for concurrent training subjects are listed in table 17-4 and paragraph 17-5*i*.

(5) The battery commander must also give careful consideration to the after-FTX recovery period. Plans should be made *before* the FTX for the post-FTX maintenance recovery period. Paragraph 18-7 gives some suggestions on this subject.

17-8. Soldiers Manual and Skill Qualification Test (SQT)

Soldiers Manuals and SQT's, to be published in the near future, will be a great benefit to the trainer. The Soldiers Manual identifies the individual tasks which are considered critical for a given MOS. For each skill level, the manual lists the tasks, conditions, and standards the soldier is expected to meet, and gives a brief outline for performance of these tasks. Many of these tasks are extracted directly from FM 6-50 and the weapon User's Manual. The SQT will examine the soldier on these same tasks, and the results will be used to verify

the soldier's MOS and determine his eligibility for promotion. When these two tools are available in the field, they will provide the commander with a means of selecting tasks for training, and evaluating soldier's individual proficiency.

17-9. Summary

The success of the field artillery cannon battery on the modern battlefield will depend heavily on the maintenance of its weapon systems and the superiority of its tactics and techniques. Of even more importance will be the proficiency of individual soldiers, sections, and batteries. The weapons and tactics of the cannon battery will be effective in combat only to the extent that we train our soldiers to exploit their full capabilities. The individual soldier must be convinced — totally convinced — that we can win on the modern battlefield. This confidence can come only from training. Therefore, above all else, the battery commander must find ways to train in today's "hostile training environment" that will improve the effectiveness of his battery in combat.

Battery-level training might use the following successive steps in approaching complete mission readiness.

- Tactical exercise without troops (TEWT).
- Command post exercise (CPX).
- Reconnaissance party rehearsals/erection drills.
- M31 field artillery trainer exercise.
- Command post exercise with base piece.
- Field training exercise (FTX).

CHAPTER 18

MAINTENANCE PROCEDURES AND TRAINING

18-1. General

Preventive maintenance (PM) of equipment is a continuing problem. The best way to beat the problem is for commanders to **FIX RESPONSIBILITY** so that each man does his job in the PM program.

18-2. Role Of The Battery Commander

The overall responsibility for maintenance rests squarely on the shoulders of the battery commander. It cannot be delegated. Battery commanders should insure that they--

a. Initiate a sound and workable PM program that assigns maintenance tasks for all battery personnel.

b. Have each man trained in the preventive maintenance of his equipment.

c. Allocate enough time for PM.

d. Inspect equipment often to be sure that equipment is properly maintained. *DA Pamphlet 750-1, Commander's Guide of Preventive Maintenance Indicators*, is helpful to commanders in making inspections.

18-3. Role Of The Section Chief

The BC/XO must hold the section chief responsible for the performance of all operator/crew maintenance on all section equipment as well as maintenance of the personal equipment of each member of his section. For example, motor sergeants should not be in charge of operator-level maintenance, communications sergeants should not be held responsible for the care of the telephones assigned to the howitzer crews, and the battery armorer should not be charged with the responsibility for the cleanliness of the weapons that are assigned to individuals and howitzer crews. To do so implies a shifting of responsibilities from the section chief.

18-4. Role Of The Battery Maintenance Section

a. Organizational maintenance is performed by mechanics of the battery and battalion maintenance sections. A key to a good

organizational maintenance program is the development of a clear and concise battalion and battery maintenance SOP that defines the responsibilities of both of these maintenance sections. **WARNING:** *A lengthy, very detailed SOP is often ignored.*

b. Battery maintenance sections are normally staffed and equipped to perform major lubrication services, emergency and routine repairs, and road tests and to assist in battlefield recovery. They have the personnel and equipment to perform most of the periodic services (quarterly, semiannual, etc.), organize recovery operations, and to give technical advice to the batteries. In some cases it is impossible for the battalion maintenance section to perform all of the periodic services. A realistic division of responsibilities for periodic services can be spelled out in the battalion maintenance SOP. For example, in an M109 howitzer battalion, a realistic approach might be for the battalion maintenance section to perform the Q services on the battalion tracked vehicles and for the battery maintenance sections to perform the S services on all their wheeled vehicles. Of course, actual division of responsibility will depend on the local situation.

c. The end product of a mechanic's labor is not always apparent to visual inspection; however, disastrous results may follow careless performance of a service or a repair job. It is essential that an equipment operator have confidence in the mechanic and in the quality of maintenance performed. Battery maintenance personnel must be motivated to do excellent work with a minimum of supervision. Supervisors should continuously spot check mechanics to be sure each is capable of--

(1) Using technical publications in the repair and service of equipment. A mechanic who never uses his technical publications is either foolishly overconfident or ignorant.

(2) Using his tools and organizational test equipment in diagnosing the source of problems and repairing the equipment.

(3) Using parts manuals to identify repair parts by correct nomenclature and national stock number and to determine recoverability, and quantity required.

(4) Determining what he is or is not authorized to do (from the maintenance allocation chart of the appropriate -20 technical manual).

(5) Recording his actions clearly on the DA Form 2404, Equipment Inspection and Maintenance Worksheet, and on appropriate logbook forms (i.e., DA Forms 2408-1 (daily), 2408-10, and 2408-14).

d. To be effective, a battery mechanic must have the necessary technical training and must be fully qualified on the types, makes, and models of equipment he is expected to inspect, service, and repair. In many cases, school-trained personnel and school quotas are not readily available. If courses scheduled by the Army school system (as listed in DA Pam 350-10) are unavailable or inappropriate, the battery commander must set up a well-supervised on-the-job training (OJT) program. In support of OJT, most service schools offer correspondence courses with standards that closely parallel those of resident courses. These courses assist battery commanders in setting up OJT programs that will increase the materiel readiness of the battery and, at the same time, provide a means for maintenance per-

sonnel to become MOS qualified and to progress to higher skill levels. Table 18-1 is a list of typical maintenance MOS's for which OJT programs may be necessary and the correspondence courses available for each.

e. Many Department of the Army publications are available to assist commanders in training maintenance personnel. Some of these publications are useful as aids in establishing OJT programs; others are designed to assist commanders in establishing formal maintenance classes. Table 18-2 is a list of these maintenance training publications.

18-5. Role Of The Operator

The cause of most equipment problems is the lack of attention to before-, during-, and after-operation maintenance by operators. The operator is the first line of defense against equipment problems. Operators are in the best position to detect and correct most equipment failures. The battery commander must remember that driver proficiency normally reflects the caliber of the unit driver selection process and the driver training program.

18-6. Operator Training And Supervision

a. The operator is the key man in the entire PM program and he must be trained to properly use and maintain the equipment

Table 18-1. Correspondence/OJT Programs.

POSITION	COURSE TITLE	ADDRESS—APPLICATION OR CATALOG
Mechanic	Wheeled Vehicle Mechanic Correspondence/OJT Course	US Army Ordnance Center and School ATTN: ATSL-TR-O Aberdeen Proving Ground, MD 21005
Mechanic	Tracked Vehicle Mechanic Correspondence/OJT Course	
TAMMS clerk	Equipment Maintenance Clerk Correspondence /OJT Course	
PLL clerk	Unit and Organizational Maintenance, Repair Parts Supply, and Storage Correspondence Course, Course 159	US Army Quartermaster School ATTN: ATSM-CD-FS Fort Lee, VA 23801
Battery motor officer	Motor Officer Course	US Army Armor School ATTN: ATSB-T-CC Fort Knox, KY 40121

Table 18-2. Maintenance Training Publications.

PUBLICATION	TITLE
DA Pam 350-24	Maintenance Supervisor's Course.
DA Pam 350-25-1	Tracked Vehicle Mechanic Course, Combat Vehicles, Armored Carrier, M113/M113A1.
DA Pam 350-25-2	Organizational Mechanic Course, Combat Vehicles, Self-Propelled Artillery.
DA Pam 350-26-1	Organizational Mechanic Course--Tactical and Support Vehicles, Truck, Utility, 1/4-Ton, 4x4, M151.
DA Pam 350-29-2	Organizational Mechanic Repairman Course--Special Purpose Equipment, Power Generator Equipment.
TC 9-71-1 PT through TC 9-71-5 PT	Programed texts for training of TAMMS clerks.
TC 10-76-1 PT, -2 PT, -3 PT, -7PT, -8 PT	Programed texts for training of PLL clerks.

that he operates. To qualify initially as an operator, a man must take a series of tests given by the local driver testing station and the unit. The Department of the Army has a number of publications that set up the standard procedures for this initial selection and testing. These publications are listed in table 18-3 and should be reviewed by all supervisors who control driver selection and training.

b. The initial testing is a start point. Before a battery commander licenses an operator and assigns him to a vehicle, he should insure that the prospective driver understands all of his responsibilities as an operator. In addition to the road test, there are many maintenance tasks that should be

taught to the prospective driver before he is licensed. Many posts/units have schools that teach these additional tasks to operators. In many cases, however, the battery commander will have to set up his own training program.

c. Because of the continuing requirement to qualify new personnel as drivers, it is not normally practical to establish battery-level classes in these tasks. The section chief should be the individual responsible for teaching these tasks in an OJT-type program before recommending the licensing of an individual. Given the proper amount of time (normally about 2 weeks), a section chief should be able to qualify his operator in these tasks during the regular battery maintenance.

Table 18-3. Driver Selection/Testing Publications.

PUBLICATION	TITLE
AR 600-55	Motor Vehicle Driver-Selection, Testing and Licensing.
AR 600-58	Mechanical Equipment Operator-Selection, Training, Testing, and Licensing.
TM 21-300	Driver Selection and Training (Wheeled Vehicles).
TM 21-301	Driver Selection, Training, and Supervision, (Tracked Vehicles).
FM 21-305	Manual for the Wheeled Vehicle Driver.
TM 21-306	Manual for the Tracked Combat Vehicle Driver.

nance periods. Table 18-4 is a *suggested* list of tasks (in an OJT program format) that might be used to train a driver before he is licensed. Some tasks are obviously not applicable to certain localities and should be disregarded.

d. In some cases the battery commander may feel that a more centralized battery-level effort is necessary. To aid in establishing his training program for operators, the battery commander/training officer might refer to the publications listed in table 18-5 in addition to those listed in table 18-3.

e. Completing the driver training program and obtaining the SF 46 should be a

challenge. The awarding of a driver's license indicates the battery commander's trust in the individual and the driver's acceptance of extra responsibilities. An imaginative battery commander will create rewards for those personnel willing to accept additional responsibilities. Examples of appropriate awards might be:

- (1) Three- or four-day passes.
- (2) Separate duty rosters for drivers (duty driver) and nondrivers (CQ runner, barracks orderly).
- (3) Promotion points allocated for promotion to E3 and E4 for possession of a driver's license.

Table 18-4. Tasks to Qualify Vehicle Operators.

PROSPECTIVE DRIVER'S NAME: _____

DATE COMPLETED INITIAL TESTING: _____

SECTION CHIEF: _____

TASK	REFERENCE	GO	NO GO	INIT
Perform before-operation checks and services on vehicle.	Operator's manual			
Perform during-operation checks and services on vehicle.	Operator's manual			
Perform after-operation checks and services on vehicle.	Operator's manual			
Prepare vehicle for tactical operations.	Operator's manual			
Prepare vehicle for operation in snow/ice.	Operator's manual			
Start the engine using the vehicle's power source.	Operator's manual			
Start the engine using auxiliary power from an outside source.	Operator's manual			
Start the engine of a vehicle by towing.	Operator's manual			
Start the engine of vehicle in extremely cold weather (real or simulated).	Operator's manual			
Operate a vehicle over various types of terrain	Operator's manual, unit SOP			

Table 18-4. Tasks to Qualify Vehicle Operators--Continued.

TASK	REFERENCE	GO	NO GO	INIT
Operate a vehicle under blackout conditions.	Operator's manual			
Operate a vehicle while backing with a trailer.	Operator's manual			
Guide a vehicle during daylight using hand and arm signals.	FM 21-60			
Guide a vehicle during the hours of darkness using a flashlight.	FM 21-60			
Extinguish a fire in a vehicle using emergency procedures.	Operator's manual			
Recover a mired vehicle using expedient means.	FM 21-305, FM 20-22			
Recover a mired vehicle from snow.	FM 21-305, FM 20-22			
Troubleshoot malfunctions using the operator's manual	Operator's manual			
Inventory basic-issue items.	Operator's manual			
Perform preventive maintenance on basic issue items.	Operator's manual			
Fill out DA Form 2408-1 (daily) for a day of operation.	TM 38-750			
Fill out heading of DA Form 2404 used to record results of operator's daily inspection.	TM 38-750			
Fill out DA Form 2404 for operator's daily inspection to indicate no new uncorrected faults discovered on vehicle.	TM 38-750			
Fill out DA Form 2404 for operator's daily inspection to annotate a fault the operator cannot correct himself.	TM 38-750			
Fill out operator's portion of DA Form 2400 for day of operation.	TM 38-750			
Fill out DD Form 518, Accident-Identification Card	FM 21-305			
Fill out SF 91, Operator's Report of Motor Vehicle Accident, for simulated motor vehicle accident.	FM 21-305			

Table 18-4. Tasks to Qualify Vehicle Operators--Continued.

TASK	REFERENCE	GO	NO GO	INIT
Perform ESC evaluation on vehicle.	ESC technical manual			
Record results of ESC evaluation on DA Form 2404.	ESC technical manual and TM 38-750			
Read Vehicle lubrication order to specify lubrication points, intervals, and lubricants.	Vehicle LO			

NOTE: The individual being tested should actually **perform** the task stated if at all practicable. Attendance at a class on the task does NOT necessarily indicate proficiency. The prospective driver should be allowed to use any reference he would normally have with the vehicle during dispatch (e.g., operator's manual, FM 21-305, lubrication order, and logbook).

The above named individual has performed the tasks specified above and is recommended as a wheeled/tracked vehicle driver.

(Signature of section chief)

(Date)

I have interviewed the above named individual, familiarized him with his duties as a wheeled/tracked vehicle driver, and recommend that he be issued this driver's license.

(Signature of Motor Officer)

(Date)

Table 18-5. Driver Training Program Aids.

PUBLICATION	TITLE
DA Pam 350-31-2	Operators Training Course--Combat Vehicles, Self-Propelled Artillery.
DA Pam 350-32-1	Operators Training Course, Tactical and Support Vehicles: Truck, Utility, ¼-Ton, 4x4, M151.
DA Pam 750-31	The M561 Gama Goat--Operation and Preventive Maintenance.
TB 9-2320-218-10-1	Safe Operation of Truck, Utility, ¼-Ton, 4x4, M151 Series.

Note. Instructors may adapt training to other tank-automotive end items by using the POI and instructional material in DA Pamphlets 350-31-2 and 350-32-1 as a guide.

18-7. Conducting A Battery Preventive Maintenance Program

Because of the nature of normal operations and maintenance in a hostile training environment, the supervision of battery maintenance activities can be a major problem for many commanders. Time is always a scarce resource. The activities of the cannon battery need to be planned and organized to avoid haphazard use or waste of maintenance time. The following are helpful hints to the battery commander in establishing and conducting his PM program. Some of these may be inappropriate for the local situation and should be disregarded.

a. There is no substitute for the battery commander's personal encouragement and personal supervision of preventive maintenance. The battery commander should make frequent unscheduled visits to the motor pool to observe the operation of the battery maintenance section and operators/crews.

b. A driver and an assistant driver should be assigned to each battery wheeled or tracked vehicle. Both the driver and the assistant should be fully trained and licensed. A master chart board should be maintained in the maintenance shop and in battery headquarters showing the assigned drivers and assistants. By assigning drivers and assistant drivers, the commander helps to fix responsibility for each item of equipment in his command. Having assigned a driver/assistant to each vehicle, the battery commander should insure that one of these individuals is with the vehicle whenever it is operated or serviced. The morale of a conscientious driver can be destroyed if someone abuses his assigned vehicle.

c. Maintenance periods should be set up so that maximum flexibility is given to the section chief in accomplishing maintenance tasks. The section chief is the individual who should be getting the heat if the maintenance on any of his equipment is substandard. Having been given mission-type maintenance orders, the section chief should be given sufficient leeway to accomplish these tasks (in the time allowed) as he sees fit. The

section chief must be concerned with the maintenance of all section equipment (individual/crew-served weapons, TA 50-901 equipment, protective masks, telephones, vehicles, etc.) and he should not be restricted in the way he uses his people and time to perform these maintenance tasks. The section chief must then have a definite plan for each maintenance period and assign crew tasks accordingly.

d. Maintenance and training cannot be categorized as separate activities to be conducted at different times. The performance of supervised maintenance during all types of field training is a must. Time can be gained if preventive maintenance training is integrated into other battery activities. For instance, it is very easy and effective to complement a class on assembly/disassembly of the M16 rifle by adding cleaning in a practical exercise portion of the class. A class on before-operation checks and services should be supplemented with hands-on performance of these tasks. In a similar way, maintenance can be incorporated into almost all training periods, and training can be incorporated into all maintenance periods.

e. Scheduled preventive maintenance services (quarterly, semiannual, etc.) are also important facets of a good PM program. These services are important because they give the organizational mechanic an opportunity to inspect (and correct) items not normally inspected during the operator's daily inspection. The battery commander should keep the following points in mind concerning preventive maintenance services.

f. Services should be programed on DD Form 314 (preventive maintenance schedule and record) by a responsible individual (motor officer or motor sergeant) to insure that services are reasonably distributed over a given period of time and do not conflict with operational commitments. Besides scheduling these services on DD Form 314, it is a good management tool to schedule these services on the battery weekly training schedule. By placing the scheduled service on the weekly training schedule, the commander shows his emphasis by equating the per-

formance of the services with all other prime training time tasks.

g. When a wheeled vehicle is undergoing a semiannual service, the driver and assistant driver should be with the vehicle. When a tracked vehicle is undergoing a quarterly service, the entire crew should be with the vehicle. These practices insure that mechanics do not spend valuable time on operator maintenance and that enough physical resources are available to perform a good service.

h. If at all possible, an entire weapon system should be serviced at the same time. For example, when an M109 self-propelled howitzer is brought in for a Q service, it is normally good policy to service its M548 cargo carrier at the same time. This will minimize the amount of administrative down time for the system.

i. A spot check can be made before the performance of a scheduled service to insure that all required items are on hand. For example, the following items are needed to properly perform the semiannual service on a 2 1/2-ton, M35-series truck: Engine oil, gear lubricant, brake fluid, dry-cleaning solvent, air cleaner element, oil filter kit, fuel filter, fuel filter gasket, fuel filter kit, clean rags, drain pan, grease gun, torque wrench, jack stands, antifreeze tester, corrosion inhibitor tester, and wheel bearing nut wrench. Of course, the required items will vary according to the item of equipment, but *unless the proper items are available, a complete service will not be possible.*

j. The battery commander should establish an SOP for the conduct of after-operation maintenance after the battery returns from any field or command post exercise. The

objective of this after-operation maintenance is to verify total accountability of all personnel and equipment and to return the unit to a state of combat readiness. This SOP should outline precise maintenance objectives to be accomplished immediately upon return and on the day(s) immediately following return to home station. The training schedule of the unit should include after-operation maintenance and, if appropriate, a planned period of compensatory time. This after-operation maintenance will reduce the time for recovery from field exercises and make a more combat-ready unit. It is of utmost importance that everyone in the battery be familiar with the after-operation SOP and that there is no misunderstanding of the battery commander's guidance.

k. A battery preventive maintenance program should appeal to the competitive urge of the American soldier. Preventive maintenance can become monotonous and boring. It requires continuous routine activity that can, and often does, become sheer drudgery. Competition, with appropriate awards, might result in outstanding performance by a driver who might not otherwise be motivated. To insure that any competition is objective, the criteria must be uniform and fair.

l. Use FM 29-2, Organizational Maintenance Operations, as a guide in developing and managing an efficient organizational maintenance program. FM 29-2 is a single source reference for commanders and staffs at battalion level and below. It provides invaluable guidance on such organizational maintenance activities as maintenance operations, management techniques, repair parts procedures, materiel readiness, and maintenance training.

APPENDICES

- A -- GENERAL FIELD ARTILLERY WEAPONS CHARACTERISTICS
- B -- HOWITZER SECTION EVALUATION AND TRAINING
- C -- TEST FOR THE QUALIFICATION OF GUNNERS
- D -- TEST FOR QUALIFICATION OF HOWITZER SECTION CHIEFS
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APPENDIX A

CHARACTERISTICS AND CAPABILITIES OF ARTILLERY WEAPONS

Caliber (inches)	Minimum recoil (inches)	Maximum recoil (inches)	Gas pressure at 70°	Minimum elevation (mils)	Maximum elevation (mils)	Mils per turn of handwheel (elevation)	Type of traverse	Maximum right traverse (mils)	Maximum left traverse (mils)	Mils per turn of handwheel (traverse)	Type of trails	Equilibrators	Brake action	Tire pressure	Panoramic telescope	Telescope mount	Elbow telescope	Range or elevation quadrant	Weight, firing (pounds)	Weight, traveling (pounds)	Length, traveling (pounds)	Width, traveling	Height, traveling	Time to emplace (minutes)	Maximum rate of fire (rd/min) (first 3 min)	Sustained rate of fire (rd/min)	Prime mover	FM	TM	Weight of HE projectile (nearest pound)	Weight of complete round, maximum charge (pounds)	Notes
2	52	1,250	-84	800	24	Axle	53	53	4 1	MB	Spring	None	20	M1	M3A1	M62	M1	1,440	1,440	10'6"	4'2"	2'9"	7	8	2.5	Hel MP 1-ton	6-78	9-319	14	18		
3	42	1,100	-84	1,156	10	Pintle	409	400	19	Split	Spring	Hand	40	M12A7D	M21A1	M16A10	M4A1	4,980	4,980	19'8"	7'	5'	3	10	3	Hel 2 1/2-ton	6-75	9-1015-203-12	33	42		
4	50	1,150	-89	1,333	10	Ball and socket	6,400	6,400	19	BC	Spring	Hand	40	M113	M134	M114	M14	3,017	3,140	22'	6'4"	5'3"	4	10	3	Hel Prcht 5/4-ton	6-70	9-1015-234-12	33	42		
11 3/4	13	None	-178	1,156	21	Ring and race	1,066	1,066	21	None	None	Veh	Track	M100	M99	M101	M1A1	53,000	53,000	19'	10'4"	10'11"	1	10	3	SP	6-77	9-7204	33	42		
12	12	None	-106	1,333	10	Ring and race	6,400	6,400	10	None	Spring	Veh	Track	M117	M145	M118	M15	46,200	46,200	20'1"	10'4"	10'	1	10	3	SP	6-79	9-2350-217-10	33	42		
11	10	1,650	0	1,156	14.8	Pintle	448	418	10.3	Split	Spring	Air hand	55	M12A7C	M25		M1A1	12,950 13,540	12,950 13,540	24'	8'	5'11"	5	4	1	5-ton	6-81	9-1025-200-12	95	109		
19 1/4	19 1/8	None	-89	1,040	F16 1/2	Ring and race	533	533	6	Veh spade	Tor- sion bar	Veh	Track	M12A7K	M95	M93	M1A1	64,000	64,000	20'	10'8"	10'2"	1	4	1	SP	6-92	9-7004	95	109		
21	16	700	-53	1,333	10	Ring and race	6,400	6,400	10	Veh spade	Hy- draulic gas	Veh	Track	M117	M145	M118C	M15	52,460	52,460	21'8"	10'4"	10'1"	1	4	1	SP	6-88	9-2350-217-10N	95	109		
24	16	700	-53	1,333	10	Ring and race	6,400	6,400	10	Veh spade	Hy- draulic gas	Veh	Track	M117	M145	M118C1	M15	53,060	53,060	29'8"	10'4"	10'1"	1	4	1	SP	6-88	9-2350-217-10N	95	109		
29	70	1,900	+35	1,156	2.5	Ring and race	533	533	5	Veh spade	Pneu	Veh	Track	M115	M137		M15	62,100	62,100	13'6"	10'4"	9'7"	2	1.5	0.5	SP	6-94	9-2300-216-10	200	228		
29	70	1,900	+35	1,156	2.5	Ring and race	533	533	5	Veh spade	Pneu	Veh	Track	M115	M137	M116	M15	58,500	58,500	24'6"	10'4"	9'7"	2	1.5	0.5	SP	6-94	9-2300-216-10	200	228		
29	70	2,300	+35	1,156	2.5	Ring and race	533	533	5	Veh spade	Pneu	Veh	Track	M115	M137	M116C	M15	62,100	62,100	37'1"	10'4"	11'5"	3	1.5	0.5	SP	6-94	9-2300-216-10	147	202		
3A	NA	NA	800	1,066		Screw	125	125		Base plate	NA	NA	NA	M34A2	M79	NA	M1A1	671	671	NA	NA	NA	1 to 3	15 to 20	APC Prcht 5/4-ton Hel	23-92	9-2008	26	26			
3A	NA	NA	114	1,067	6.17	Pintle	178	178	1.9	Split	None	None	25	XM53 E2	XM37	XM109	M1A1	4,240 (Loaded)	1,209	12'8"	7'0"	5'11"	30	45 rds in 15 sec	2 1/2-ton	6-54	9-1055-215-12	58	74			

Notes

MP--Mule pack
Prcht--Parachute
1/4-ton--Jeep
2 1/2-ton--Truck
M8--Tractor
T10--Transporter
5-ton--Truck
3/4-ton--Truck
10-ton--Truck
Hel--Helicopter

APPENDIX A

CHARACTERISTICS AND CAPABILITIES OF ARTILLERY

Chg 8 1 rd/min for 60 min, then 1 rd/3 min thereafter
 : Maximum of 300 cone 3 rounds
 HSW--Horizontal sliding wedge
 VSW--Vertical sliding wedge
 STIS--Stepped thread, interrupted screw
 TIS--Thread interrupted screw
 Elec--Electric
 EI--Electrical or inertia
 PH--Percussion hammer
 CP--Continuous pull
 SIP--Spring actuated, inertia percussion
 HPC--Hydropneumatic constant
 CHSP--Concentric hydropneumatic
 HHPV--Hydropneumatic variable
 HP--Hydropneumatic
 IS--Hydrospring
 MB--Modified box
 BG--Box girder

Caliber and model	Maximum muzzle velocity (feet per second)	Maximum range (meters)	Length (gun or howitzer) (overall inches)	Life in full service (rounds)	Type of breechblock	Type of firing mechanism	Type of recoil mechanism	Minimum recoil (inches)	Maximum recoil (inches)	Gas pressure at 70°	Minimum elevation (mils)	Maximum elevation (mils)	Mils per turn of handwheel (elevation)	Type of traverse	Maximum right traverse (mils)	Maximum left traverse (mils)	Mils per turn of handwheel (traverse)	Type of trails	Equilibrators	Brake action	Tire pressure	Panoramic telescope	Telescope mount	Other
75-mm pack howitzer M116, towed	181	8,800	47	20,000	HSW	CP M13	HPC	27	32	1,250	-89	800	24	Axle	53	53	4 1	MB	Spring	None	20	M1	M3A1	M62
105-mm howitzer M101A1, towed	472	11,000	101.3	M2A1 5,000 M2A2 7,500	HSW	CP M13	HPC	39	42	1,100	-89	1,156	10	Pintle	409	400	19	Split	Spring	Hand	40	M12A7D	M21A1	M16A10
105-mm howitzer M102, towed	474	11,500	131.6	5,000	VSW	CP	HHPV	30	50	1,150	-89	1,333	10	Ball and socket	6,400	6,400	19	BG	Spring	Hand	40	M113	M134	M114
105-mm howitzer M52A1, SP	472	11,000	101.3	5,000	VSW	SIP	CHSP	11 3/4	13	None	-178	1,156	21	Ring and race	1,066	1,066	21	None	None	Veh	Track	M100	M99	M101
105-mm howitzer M108, SP	494	11,500	131.6	3,000	VSW	SIP	CHSP	12	12	None	-106	1,333	10	Ring and race	6,400	6,400	10	None	Spring	Veh	Track	M117	M145	M118
155-mm howitzer M114A1, towed	564	14,600	149.2	M1 2,000 M1A1 7,500	STIS	PH M1	HHPV	41	60	1,650	0	1,156	14.8	Pintle	448	418	10.3	Split	Spring	Air hand	55	M12A7C	M25	
155-mm howitzer M123A1, aux prop	564	14,600	149.2	5,000	STIS	CP M34	HS	19 1/4	19 3/8	None	-89	1,040	F16 1 S2	Ring and race	533	533	6	Veh spade	Tor-sion bar	Veh	Track	M12A7K	M95	M93
155-mm howitzer M44A1, SP	564	14,600	149.2	M126 5,000 M126A1 7,500	STIS	CP M35	HHPV	24	36	700	-53	1,333	10	Ring and race	6,400	6,400	10	Veh spade	Hy-draulic gas	Veh	Track	M117	M145	M118C
155-mm howitzer M109, SP	564	14,600	149.2	5,000	TIS	CP M35	HHPV	24	36	700	-53	1,333	10	Ring and race	6,400	6,400	10	Veh spade	Hy-draulic gas	Veh	Track	M117	M145	M118C
155-mm howitzer M109A1, SP	564	14,600	149.2	5,000	TIS	CP M35	HHPV	24	36	700	-53	1,333	10	Ring and race	6,400	6,400	10	Veh spade	Hy-draulic gas	Veh	Track	M117	M145	M118C
8-inch howitzer M110E2, SP	747	20,700	324.0	7,000	STIS	CP M35	HHPV	29	70	1,900	135	1,156	2.5	Ring and race	533	533	5	Veh spade	Pneu	Veh	Track	M115	M117	
8-inch howitzer M110, SP	594	16,800	216.0	7,500	STIS	CP M35	HHPV	29	70	1,900	135	1,156	2.5	Ring and race	533	533	5	Veh spade	Pneu	Veh	Track	M115	M117	M116
175-mm gun M107, SP	914	32,700	422	5-400	STIS	CP M35	HHPV	29	70	2,300	135	1,156	2.5	Ring and race	533	533	5	Veh spade	Pneu	Veh	Track	M115	M117	M116C
4.2-inch mortar M30	293	5,650	68.5	4,221" Pullover	NA	Fixed firing pin	Spring only	NA	NA	NA	800	1,065		Screw	125	125		Base plate	NA	NA	NA	M14A2	M79	NA
115-mm multiple rocket launcher M91	NA	10,600	NA	NA	NA	Elec	NA	NA	NA	NA	114	1,067	6.37	Pintle	178	178	1 1/2	Split	None	None	25	XM53 E2	XM7	XM109





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APPENDIX B

HOWITZER SECTION EVALUATION AND TRAINING

Purpose and Scope

This appendix is an evaluation and training guide for the howitzer sections of a cannon firing battery. It is universal in scope and can be readily adapted to all cannon weapon systems currently in the Army inventory. It is a performance-oriented evaluation designed to extend and amplify the performance objectives for a howitzer section that are contained in the current ARTEP. It may be administered--

- Formally or informally.
- With a minimum of administrative support.
- In the local training area.
- In a nonfiring but tactical environment.

The evaluation can be used by the commander--

- As a basis for a howitzer crew training program in preparing for the battery or battalion ARTEP.
- To evaluate the current state of training proficiency of the howitzer sections.
- As a competitive test to determine the best howitzer section within a unit.

Purpose

The evaluation is a performance test of the skills that are essential to the successful accomplishment of the mission of the individual howitzer section. Although many of the tasks are evaluated on the basis of individual performance, the evaluation will in fact measure the ability of the section to function as a team. In order to successfully complete this evaluation, each section member must be able to perform the duties of all the cannoneers in a howitzer section. It actively tests the ability of the section chief to organize and train his personnel into a cohesive, effective fighting unit.

The tasks in the evaluation include the nonfiring training objectives in the ARTEP for the individual howitzer sections as well as those general training objectives that apply to all sections in the battery. Only those tasks that can be easily administered in a small local training area are included in this evaluation.

Evaluation Procedures

The evaluation consists of an orientation station and five performance stations. The evaluation is most effectively administered when the *round-robin* rotational procedure is used. Using this procedure, all six howitzer sections of a firing battery can be evaluated simultaneously.

The six stations are organized as follows:

STATION	TASK	SUBPOINTS	TOTAL POINTS
I	Orientation/Organization	NA	NA
II	1. End-for-End Test	30	
	2. Micrometer Test	30	
	3. Boresighting	40	
	4. Breachblock	50	150

STATION	TASK	SUBPOINTS	TOTAL POINTS
III	1. Inspection of Howitzer and Prime Mover/Cargo Carrier	50	100
	2. Written Test	50	
IV	1. Gun Guide Evaluation	75	300
	2. Deliberate Occupation	190	
	3. Hasty Displacement	35	
V	1. Hasty Occupation	100	400
	2. 6,400-mil Mission	100	
	3. Indirect and Direct Laying (Missions)	200	
VI	Two Selected Tasks	50	50
Total points			1,000

The section performs certain tasks at each station. There are performance tests that are evaluated within a timed framework on a GO/NO GO basis. The score for each task is based upon the criteria contained in the standards. In order to provide a basis for competitive evaluation, many of the time standards in this evaluation are more difficult than the standards for similar tasks in the ARTEP. The minimum score that will be awarded for any one standard is 0.

Qualification

If the evaluation is administered solely for the purpose of determining the state of training of individual sections within a unit, no formal score is required. The commander can readily determine the strengths and weaknesses of his sections simply by subjectively analyzing the GO or NO GO ratings received for each task performed.

If the evaluation is used to determine the best section in a unit, a formal score must be determined. To determine the score for individual sections, add the numerical score attained at each of the five evaluated stations. The following qualification scheme should be used for formal evaluation:

Points	Rating
0 - 699	Unqualified
700 - 799	Satisfactory
800 - 899	Excellent
900 - 950	Outstanding
951 - 1000	Distinguished

Appropriate awards, such as distinctive patches and 3-day passes, should be given to recognize outstanding and distinguished howitzer sections.

STATION I

Task: Orientation and Organization.

At this station the following will be accomplished:

- All personnel will be briefed as to the conduct and purpose of the training.
- Sections will be broken down to initial stations.
- The scoring system will be explained.
- The organization of the training area and general administrative and safety procedures will be explained.
- All questions will be answered.

- Any changes in the status of section members from that indicated the previous day will be noted.

STATION II

Task 1: Perform The End-For-End Test Of The Gunner's Quadrant.

Conditions

- The examiner will select one section member, other than the section chief, to perform the task.
- An assistant designated by the section chief will elevate or depress the tube at the direction of the examinee.
- The section chief may SUPERVISE the actions but MAY NOT physically perform any part of the task.
- The section will provide its own gunner's quadrant.
- At the conclusion of the task, the examiner will check the level of the gunner's quadrant bubble prior to removing the gunner's quadrant from the breech.

Standards

A NO GO awarded for any of the following standards will cause the task to be invalid and will result in the section receiving 0 points for the entire task.

- The bubble in the gunner's quadrant is centered when checked by the examiner.
- The gunner's quadrant error, if any, is correctly announced by the examinee.
- The examinee declares the quadrant unserviceable if the error exceeds ± 0.4 mil or declares the quadrant serviceable if the error is ± 0.4 mil or less.

GO	NO GO

If the examinee receives all GO ratings for the above standards, the scores for the task will be determined by the speed of execution.

Time (in minutes)	Points
0 - 1:00	30
1:01 - 1:30	25
1:31 - 1:50	20
1:51 - 2:05	15
2:06 - 2:15	10
2:16 - 2:20	5
Longer than 2:20	0

Task 2. Perform The Micrometer Test Of The Gunner's Quadrant.

Conditions

- The examiner will select one member of the section, OTHER than the section chief or the individual who performed task 1, to perform the task.

- An assistant designated by the chief of section will elevate or depress the tube at the direction of the examinee.

- The section chief may SUPERVISE the actions but MAY NOT physically perform any part of the task.

- The section will provide its own gunner's quadrant.

- At the conclusion of the task, the examiner will check the level of the gunner's quadrant bubble prior to removing the gunner's quadrant from the breech.

Standards

A NO GO awarded for any of the following standards will cause the task to be invalid and will result in the section receiving 0 points for the task.

- The examinee follows the correct procedures in performing the task.

- The examinee announces the micrometer is or is not in error.

GO	NO GO

If the examinee receives all GO ratings for the above standards, the score for the task will be determined by the speed of execution.

Time (in minutes)	Points
0:00 - 0:30	30
0:31 - 0:50	23
0:51 - 1:05	16
1:06 - 1:15	9
1:16 - 1:20	2
Longer than 1:20	0

Task 3: Boresight By The Testing Target Method.

Conditions

- The piece will be emplaced on level ground.

- The section will provide all the necessary tools and equipment.

- The section will make no prior preparations for the performance of the task other than centrally locating all necessary tools and equipment (i.e., muzzle boresight strings will not be installed and the testing target will not be previously emplaced).

- The task will begin when the section—

- Is formed to the rear of the piece.

- Understands the task to be performed.

- Has centrally located all needed equipment.

- Receives the command of BORESIGHT from the examiner.

- Prior to the start of the tasks, the examiner will adjust the panoramic telescope out of boresight by 3 to 5 mils in both azimuth and elevation.

- Prior to the start of the task, the examiner will adjust the elbow telescope (if applicable) out of boresight by 300 to 500 meters in range and by 3 to 5 mils in direction.

- The tension will be taken off the breech for the M109/M109A1.

Standards

A NO GO awarded for any one of the following standards will cause the task to be invalid and will result in the section receiving 0 points for the task:

- The testing target is emplaced a minimum of 50 meters from the howitzer.

- The testing target is made *secure* after it is emplaced; i.e., it is not held up solely by one or two cannoneers.

- The section makes all indicated adjustments.

- The azimuth counter (scale) reads exactly 3200.

- The vertical and horizontal crosshairs on both telescopes, if applicable, and the centerline of the bore fall on their respective sighting points on the testing target.

- The breech boresight disk and muzzle boresight strings are used.

- The section chief verifies the boresight.

GO	NO GO

If the section receives all GO ratings for all the standards above, the score for the task will be determined by the speed of execution.

Time (in minutes)	Points
0 - 2:30	40
2:31 - 3:00	30
3:01 - 3:15	20
3:16 - 3:25	10
Longer than 3:25	0

Task 4: Breech Mechanism (Disassemble, Assemble, Name Parts And Explain Lubrication Measures).

Conditions

- The examiner will select the following number of section members, *other than the section chief*, to perform the task:

M101A1--one section member.

M109/M109A1, M114, M102--two section members.

M110/M110E2/M107--three section members.

- The section chief may supervise all actions but may not physically perform any operation or aid in the naming of parts or the explanation of lubrication procedures.

- All required tools will be assembled at the howitzer prior to the start of the task.

- Disassembly of the breech mechanism will include--

- a. Removal of breechblock.
- b. Disassembly of firing mechanism.
- c. Disassembly of obturator group, as applicable.

Standards

•The breechblock, obturator group, and firing mechanism, as applicable, are disassembled in accordance with the appropriate technical or user's manual.

GO	NO GO

Note. If a GO rating is awarded for the standards above, the disassembly will be graded according to speed of execution. If a NO GO is awarded, 0 points will be awarded for disassembly phase.

Disassembly Time (in minutes)

<u>M110/M107/ M109/M109A1</u>	<u>M101</u>	<u>M102</u>	<u>M114</u>	<u>Points</u>
0 - 3:30	0 - 1:00	0 - 2:00	0 - 3:45	15
3:31 - 4:00	1:01 - 1:15	2:01 - 2:25	3:46 - 4:05	11
4:01 - 4:20	1:16 - 1:25	2:26 - 2:40	4:06 - 4:20	7
4:21 - 4:30	1:26 - 1:30	2:41 - 2:45	4:21 - 4:30	3
Longer than 4:30	Longer than 1:30	Longer than 2:45	Longer than 4:30	0

- Each disassembled part is correctly named.

Penalty points

Minus 2 points for each incorrectly named part.

- The breech mechanism is properly assembled in accordance with the appropriate technical manual.

GO	NO GO

Note. If a GO rating is awarded for this standard, the assembly will be graded according to speed of execution. If a NO GO is awarded, no points will be awarded for the assembly phase.

Assembly Time (in minutes)

<u>M110/M107/ M109/M109A1</u>	<u>M101</u>	<u>M102</u>	<u>M114</u>	<u>Points</u>
0 - 4:00	0 - 1:45	0 - 2:30	0 - 4:15	15
4:01 - 4:30	1:46 - 2:00	2:31 - 3:00	4:16 - 4:35	11
4:31 - 4:50	2:01 - 2:10	3:01 - 3:20	4:36 - 4:50	7
4:51 - 5:00	2:11 - 2:15	3:21 - 3:30	4:51 - 5:00	3
Longer than 5:00	Longer than 2:15	Longer than 3:30	Longer than 5:00	0

- Proper lubrication procedures are explained, to include--

- a. Lubricants and cleaners used.
- b. Frequency of cleaning.
- c. Items and manner of lubrication.

Penalty points

Minus 2 points for each lubricant not used, lubrication point not named, or incorrect frequency stated.

- Scoring for this task is summarized as follows:

Standards	Possible Points
Disassembly	15
Part nomenclature	10
Assembly	15
Lubrication procedures	10
Total	50

STATION III

Task 1: Organizational Maintenance Inspection Of The Howitzer And Prime Mover/Cargo Carrier.

Conditions

•The howitzer and prime mover/cargo carrier will be inspected for operator/crew-level maintenance in a field environment by the battalion maintenance technician or a qualified senior mechanic.

- The inspection will be conducted on a hardstand or other level surface.

- The inspection will include--

a. A check of all operator/crew-level maintenance on the howitzer and prime mover/cargo carrier.

b. A check of section logbooks for operator-level entries on the appropriate forms.

•Sample checklists for inspection of the *fire control* and *turret* items are provided on the following pages for each type of howitzer.

Standards	Possible Points	Penalty Points
•Operator/crew-level maintenance on the howitzer is performed.	20	Minus 1 point for each shortcoming/deficiency
•Operator entries on howitzer logbook forms are correct.	5	Minus 1 point for each incorrect or omitted item
•Operator/crew-level maintenance on the prime mover/cargo carrier is performed.	20	Minus 1 point for each shortcoming/deficiency
•Operator entries on cargo carrier/prime mover logbook forms are correct.	5	Minus 1 point for each incorrect or omitted item.

•If the prime mover/cargo carrier is not available for inspection, the point total for the howitzer and its logbook will be doubled to determine the final task score.

INSPECTION CHECKLIST
SELF-PROPELLED 155-MM HOWITZER M109/M109A1--TRAVELING
AND FIRING POSITIONS

ITEM NUMBER	GO	NO GO
1. Is the fighting compartment clean and spot painted where necessary?		
2. Does the main accumulator have the correct amount of oil and nitrogen gas?		
3. Do the traverse and elevation systems operate smoothly? (Check both power and manual operation.)		
4. Are there signs of oil leakage in the hydraulic system?		
5. Is the electrical system complete and serviceable? (Check switches and conduits for damage and fungus growth.)		
6. Is the vehicle intercommunications set, AN/VIC-1, operative? Are connectors and binding posts clean and free of paint?		
7. Is the equilibrator properly adjusted for temperature?		
8. Check the recuperator pins. Is the pin extension between one-eighth and three-fourths of an inch?		
9. Does the recoil mechanism leak in excess of three drops per 5 minutes?		
10. Does the replenisher gage indicate the proper amount of pressure?		
11. Does the breech mechanism operate freely?		
12. Are the breechblock closing springs properly adjusted?		
13. Is the firing mechanism operating properly?		
14. Are the breechblock and breech recess threads free of burs and scores?		
15. Is the bore properly lubricated? (The bore should be wiped dry before firing.)		
16. Is the bore free of pits, dirt, and foreign matter?		
17. Are the chamber evacuator valves clean?		
18. Are the sights and sight mounts properly adjusted?		
19. Is the panoramic telescope lens clean and free of scratches, dirt, and dust?		
20. Is the testing target serviceable?		
21. Is the elevation counter properly adjusted?		
22. Is the .50 caliber machinegun ring on the commander's cupola functioning properly (moves freely, lock works, and bearing is lubricated)?		
23. Are the access doors and hatch covers working properly?		
24. Is the radiator coolant level to the top of the filler neck?		
25. Is the engine oil level (cold engine) at or above the full mark?		

ITEM NUMBER	GO	NO GO
26. Is the transmission oil level within the operating range on the dipstick?		
27. Is there evidence of water or other contaminants in the primary fuel filter?		
28. Is the oil level visible halfway up in the sight indicator on all of the road wheels?		
29. Is the track tension properly adjusted?		
30. Are there any loose end connectors or dead track blocks?		
31. Are the engine air cleaner filter packs clean?		
32. Is the oil level in the final drives level with the plug opening?		
33. Are the batteries clean, are connections tight, and is the electrolyte level proper?		

INSPECTION CHECKLIST
TOWED 105-MM HOWITZER M101A1—FIRING POSITION

ITEM NUMBER	GO	NO GO
1. Is the breechblock operating properly?		
2. Is the catch for the breechblock operating handle operating properly?		
3. Is the breech mechanism properly lubricated?		
4. Are the leveling plates clean and free of scratches?		
5. Is the elevating handwheel in proper adjustment? (Allowable free play, or backlash, is one-sixth of a turn.)		
6. Is the equilibrator in proper adjustment? (Tube should elevate and depress smoothly through entire range of elevation without undue effort.)		
7. Is the range quadrant free from binding or excessive play?		
8. Is the traversing handwheel in proper adjustment? (Allowable free play, or backlash, is one-sixth of a turn.)		
9. Is the panoramic telescope mount free from binding or excessive play?		
10. Is the panoramic telescope lens clean and free of scratches?		
11. Are the trail locking pins properly positioned?		
12. Are the axle locks disengaged?		
13. Is the drawbar properly positioned?		
14. Are the elevating arcs and pinions free of dirt, rust, and burs?		
15. Is the cradle clean and properly lubricated?		
16. Is the recoil piston rod outer locking nut properly adjusted?		

ITEM NUMBER	GO	NO GO
17. Does the recoil mechanism contain the proper oil reserve? (Sufficient oil reserve is indicated when the oil index is flush with the front face of the recuperator cylinder.)		
18. Is the bore clean and free of pits?		

INSPECTION CHECKLIST
(2½-TON TRUCK) M35A2

ITEM NUMBER	GO	NO GO
1. Is the radiator coolant level up to the filler neck?		
2. Is the engine oil level between ADD and FULL on the dipstick?		
3. Is there evidence of water or other contaminants in the fuel filters?		
4. Is there water in the air tanks?		
5. Are any of the dual wheels flat?		
6. Are the batteries clean, are connections tight, and is the electrolyte level proper?		
7. Is there any evidence of fuel, oil, water, or air leaks?		

INSPECTION CHECKLIST
TOWED 105-MM HOWITZER, M102--TRAVELING
AND FIRING POSITION

ITEM NUMBER	GO	NO GO
1. Is the equipment logbook present, complete, and properly stowed?		
2. Are the breech cover assembly and fire control instrument covers present, clean, and free of grease and dirt?		
3. Are the taillights and cables in good working order?		
4. Are the carriage mounting brackets operational?		
5. Is the bore clean and free of pits? Has the tube life been expended?		
6. Does the breech mechanism operate freely?		
7. Is the firing linkage serviceable?		
8. Is the elevating mechanism working smoothly during elevating and depressing of the cannon tube?		
9. Does the handgrip on the elevating handwheel spin freely on the spindle?		
10. Is the correct amount of oil reserve present in the recoil mechanism? Is the recoil piston rod nut tight, and is the cotter pin in place?		

ITEM NUMBER	GO	NO GO
11. Does the travel lock operate freely, and is it in proper alinement?		
12. Is the buffer leaking oil?		
13. Is the actuating mechanism functioning properly, and is the firing platform free of damage?		
14. Are the firing stakes properly emplaced?		
15. Are the handbrakes in proper adjustment?		
16. Are all items of BII present and serviceable?		
17. Is the rubber eyeshield free of deterioration, fungus growth, and dirt?		
18. Check instrument lights M52 and M53. Are the lead wires frayed, or do they have broken insulation?		
19. Do the operating controls of the telescope mount M134 move without binding and are the stops positive?		
20. Is the operation of the telescope mount M134 compensating mechanism accurate?		
21. Do the operating controls of the panoramic telescope M113 move without binding and are the stops positive?		
22. Do the operating controls of the quadrant M14 move without binding and are the stops positive?		
23. Check the reset lamp. Does it light when turned on?		

INSPECTION CHECKLIST
(1½-TON TRUCK) M561

ITEM NUMBER	GO	NO GO
1. Is the radiator coolant one-half inch below the filler neck of the surge tank?		
2. Is the engine oil level between ADD and FULL on the dipstick?		
3. Is there evidence of water or other contaminants in the fuel filter?		
4. Are the three body drain plugs installed?		
5. Are the batteries clean, are connections tight, and is the electrolyte level proper?		
6. Is there evidence of oil, water, or fuel leaks?		
7. Is the articulation joint loose or damaged?		
8. Are the hitch pins in place?		
9. Does the tailgate properly seal?		

INSPECTION CHECKLIST
TOWED 155-MM HOWITZER M114A1— TRAVELING POSITION

ITEM NUMBER	GO	NO GO
1. Is the trail traveling lock properly latched?		
2. Is the trail lockpin in the traveling position?		
3. Are the handspike, rammer staff, and aiming posts properly secured in brackets?		
4. Are the air lines in good condition and properly assembled?		
5. Are the air hose couplings clean and in good condition?		
6. Are the lockpins and chains present and in good condition?		
7. Is the firing jack float in the proper position for traveling?		
8. Are the spade keys present?		
9. Are the lubrication fittings in good condition?		
10. Is there excess grease or oil on the weapon?		
11. Are the tires properly inflated?		
12. Are the valve caps present?		
13. Are the wheels, wheel stud nuts and hub cap screws properly tightened?		
14. Is the howitzer cover serviceable, free of dirt and tears, and properly secured?		
15. Is the sight box latched and locked?		
16. Are the handbrakes properly adjusted?		
17. Are the shields secured in the traveling position?		
18. Are the welds unbroken and all nuts present and secure?		
19. Is the blackout system properly installed?		

INSPECTION CHECKLIST
TOWED 155-MM HOWITZER M114A1—FIRING POSITION

ITEM NUMBER	GO	NO GO
1. Are all bearing surfaces free of rust and properly lubricated?		
2. Is the test target serviceable?		
3. Is the elevation scale properly adjusted for firing?		
4. Is the panoramic telescope lens free of scratches, dirt and dust?		
5. Are the airbrake hoses attached to the dummy coupling?		

ITEM NUMBER	GO	NO GO
6. Is the breech mechanism properly lubricated?		
7. Is the bore free of pits, rust, and dirt? (Bore should be dry for firing.)		
8. Is the headspace properly adjusted?		
9. Are the leveling plates free of dirt, rust, pits, and scratches?		
10. Does the breechblock open and close without binding?		
11. Is the breechblock operating handle latch serviceable?		
12. Are the split rings on the obturator 3,200 mils apart?		
13. Is the firing mechanism M1 serviceable?		
14. Is the jack float properly assembled (beveled edge to rear)?		
15. Are the arcs and pinions free of dirt, burs, and rust?		
16. Does backlash in the elevation and traversing handwheels exceed one-sixth of a turn?		
17. Are the equilibrators properly adjusted?		
18. Is the tire pressure stenciled on the trail?		
19. Are there any loose or missing bolts, nuts, or cotter pins?		
20. Does the replenisher contain the proper amount of recoil oil?		
21. Does the recuperator contain the proper amount of recoil oil?		

INSPECTION CHECKLIST M813 (5-TON)

ITEM NUMBER	GO	NO GO
1. Is the radiator coolant level halfway up in the surge tank (before operation)?		
2. Is the engine oil level between H and L on the dipstick?		
3. Is there evidence of water or other contaminants in the fuel filter?		
4. Is there water in the air tanks?		
5. Are any of the dual tires flat?		
6. Are the batteries clean, are connections tight, and is the electrolyte level proper?		
7. Is there any evidence of fuel, oil, water, or air leaks?		

INSPECTION CHECKLIST
SELF-PROPELLED 8-INCH HOWITZER M110 AND
SELF-PROPELLED 175-MM GUN M107--TRAVELING AND FIRING POSITION

ITEM NUMBER	GO	NO GO
1. Are all bearing surfaces and exposed unpainted parts clean and properly lubricated?		
2. Do painted areas show signs of rust where paint has been chipped away?		
3. Are name plates, caution plates, and instruction plates free of rust and paint?		
4. Is the bore clean and free of pits, dirt, and foreign matter?		
5. Does the breech mechanism operate freely?		
6. Are the breechblock and breech recess threads free of burrs and scores?		
7. Does the recoil mechanism show signs of oil leakage?		
8. Does the replenisher contain the proper amount of recoil oil?		
9. Does the hydraulic reservoir contain the proper amount of oil?		
10. Are there signs of oil leakage in the hydraulic system?		
11. Do the traverse and elevation systems operate smoothly? (Check both power and manual operation. Systems should not have jerky motions). Are there any hydraulic leaks in the system?		
12. Do the spade cylinders operate properly?		
13. Does the loader-rammer assembly function properly? (Check all movements. Check electrical connections for completeness and tightness. Check for hydraulic leaks.)		
14. Are the telescopes properly mounted?		
15. Is the telescope lens clean and free of scratches?		
16. Is the M15 range quadrant in adjustment?		
17. Do the reset counter, gunner's aid counter, and azimuth counter work properly?		
18. Does the counterbalance function properly?		
19. Does the recuperator cylinder index indicate the proper level?		
20. Is the vehicle intercommunications set, AN/VIC-1, operative? Are connectors and binding posts clean and free of paint?		
21. Is the M137 telescope mount properly aligned and adjusted?		
22. Is the night lighting wiring harness for the M137 and M15 mounts (to include XM52) present and serviceable?		
23. Does the M35 firing mechanism function properly and is the firing pin serviceable?		
24. Does the manual handpump for the hydraulic system operate smoothly, and can it be used to manually pressurize the hydraulic system?		

ITEM NUMBER	GO	NO GO
25. Does the travel lock operate freely and lock securely?		
26. Is the radiator coolant level to the top of the filler neck? (both radiators)?		
27. Is the engine oil level (cold engine) at or above the FULL mark on the dipstick?		
28. Is the transmission oil level within the operating range on the dipstick?		
29. Is there evidence of water or other contaminants in the primary fuel filter?		
30. Is the oil level in the final drives level with the plug opening?		
31. Is the track tension properly adjusted?		
32. Are the engine air filter packs clean?		
33. Are the air cleaner access doors or gaskets damaged or do they show evidence of leaks?		

INSPECTION CHECKLIST .50 CALIBER MACHINEGUN M2

HEADSPACE

EXCESSIVE _____

TIGHT _____

PROPER _____

Note. Clear the machinegun and cock firing pin. Ease the recoiling parts to the forward position. Pull the retracting handle and recoiling parts rearward until there is approximately one-sixteenth-inch clearance between the barrel extension and the trunnion block. Insert the GO end of the headspace gage between the rear of the barrel and the face of the bolt. The gage should drop freely. If it does not, the headspace is *tight*. Insert the NO GO end of the headspace gage between the rear of the barrel and the face of the bolt. The NO GO gage should not go. If the NO GO gage does go, the headspace is *excessive*. Headspace is *proper* when the GO gage goes and the NO GO gage does not go. A GO grade is awarded *only* if headspace is proper.

TIMING

EARLY _____

LATE _____

PROPER _____

Note. Clear the machinegun and cock the firing pin. Insert the *NO FIRE* gage between the barrel extension and the trunnion block. Press down on the trigger. The firing pin should not release. If the firing pin releases, the timing is *early*. Insert the *FIRE* gage between the barrel extension and the trunnion block. Press down on the trigger. The firing pin should release. If the

firing pin does not release, the timing is *late*. Proper timing is indicated when the machinegun *will not* fire with the NO FIRE gage inserted and *will fire* with the FIRE gage inserted. A GO grade is awarded *only* if timing is proper.

Task 2: Written Test (50 Points).

Conditions

- This test may be administered in garrison prior to the performance tasks, or it may be given to the section while the vehicles are being inspected during the field maintenance inspection (Task 1).

- All section members, except the section chief, will take the written test.

- The examiner will select 20 questions from the lists of questions on the following pages appropriate for the weapon system being evaluated.

- The scores for the section members will be averaged to determine the section score.

- Thirty minutes will be allotted for the test.

Standards

Each question will have a weight of 2.5 points, for a total of 50 possible points.

1. An enemy soldier has just surrendered to your unit. Can any of his property be kept as a war trophy?

a. Yes.

b. No.

2. Can prisoners under the control of your unit be killed if it is certain that they have been engaged in combat against your unit?

a. Yes.

b. No.

3. A prisoner of war is required to give--

a. his name, rank, service number, and date of birth.

b. whatever information is requested of him if it has legitimate military significance.

c. whatever information is requested of him if it has no military significance.

d. no information whatsoever.

4. Can a captured American soldier be required to work in an enemy munitions factory to pay for his food?

a. Yes.

b. No.

5. An order was given to remove the ears from every enemy killed and to bring the ears back as proof of the kill. Must you obey the order?

a. Yes.

b. No.

6. The M26/M26A1 fragmentation hand grenade has an effective casualty radius of--
 - a. 3 meters.
 - b. 5 meters.
 - c. 10 meters.
 - d. 15 meters.
7. Corrosive damage to the interior of an artillery tube results from the--
 - a. failure to clean dust and dirt from the tube before firing.
 - b. friction created as the projectile moves through the bore.
 - c. escape of gas from behind the rotating band.
 - d. absorption of moisture by the residue of primer salts.
8. The maximum range at which you can expect to kill a target with the M16A1 rifle (maximum effective range) is--
 - a. 2,350 meters.
 - b. 375 meters.
 - c. 400 meters.
 - d. 2,653 meters.
9. The maximum range of the M16A1 rifle is--
 - a. 450 meters.
 - b. 2,400 meters.
 - c. 2,653 meters.
 - d. 3,125 meters.
10. Cover is--
 - a. protection from enemy observation.
 - b. protection from enemy fire.
 - c. used only by the infantry soldier.
 - d. available only during periods of reduced visibility.
11. A secret word that is given only to those persons entitled to inspect the guard and to commanders and members of the guard is the--
 - a. countersign.
 - b. challenge.
 - c. password.
 - d. parole word.

12. The four lifesaving measures are--

- a. clear the airway and restore breathing and heartbeat as necessary.
- b. administer shock control.
- c. apply dressing and bandage.
- d. stop the bleeding.

The proper sequence for these measures is--

- 1. a, b, c, d.
- 2. d, a, c, b.
- 3. c, a, b, d.
- 4. b, a, c, d.

13. If any member of the battery observes a dangerous situation, he can stop a fire mission already in progress by giving the command--

- a. STOP FIRING.
- b. CANCEL FIRING.
- c. CEASE FIRE.
- d. CHECK FIRING.

14. Aiming the howitzer by sighting on an aiming point other than the target is called--

- a. direct laying.
- b. indirect laying.
- c. referring.
- d. special corrections.

15. For best results, the collimator should be emplaced _____ to _____ meters from the howitzer.

- a. 3 to 13.
- b. 4 to 15.
- c. 0 to 15.
- d. 3 to 10.

16. Regardless of the distance at which the far aiming post is set, the near aiming post must be emplaced--

- a. about 50 meters from the howitzer.
- b. exactly half the distance to the far aiming post.
- c. as the situation permits.
- d. 100 meters from the howitzer.

17. In a fire command, the number 3167 is pronounced--
- thir-tee wun six-tee seven.
 - thuh-ree-thouzand wun six seven.
 - thuh-ree wun six seven.
 - three thouzand wun hundred six-tee seven.
18. Number 2 desires the FDC to repeat the deflection. Number 2 should say--
- REPEAT DEFLECTION, NUMBER 2.
 - NUMBER 2, DEFLECTION?
 - DEFLECTION, NUMBER 2?
 - SAY AGAIN DEFLECTION, NUMBER 2.
19. When separate-loading ammunition is being fired the fire command for lot includes two letters, XY. The ammunition component(s) represented by the letter "X" in lot XY is (are)--
- propellant.
 - projectile.
 - propellant and projectile.
 - propellant, projectile, and fuze.
20. In addition to reducing flash, a flash reducer is used with certain weapons to prevent--
- excessive muzzle blast.
 - a smoke problem.
 - excessive wear of the tube.
 - overheating of the tube.
21. The *primary* reason for painting projectiles is to--
- prevent rust and corrosion.
 - provide an easy method of identification.
 - facilitate handling and storage.
 - enhance the camouflage of the position.
22. If ammunition in outside storage is covered by a tarpaulin, the airspace between the tarpaulin and the ammunition stack must be a minimum of--
- 6 inches.
 - 12 inches.
 - 18 inches.
 - 24 inches.

23. The 155-mm howitzer white bag propelling charge M4A2 consists of a base charge plus increments numbered--

- a. 2 through 5.
- b. 2 through 7.
- c. 4 through 7.
- d. 1 through 7.

24. Field artillery cannon ammunition is classified according to type as--

- a. fixed and separate.
- b. separate and semifixed.
- c. semifixed and separate-loading.
- d. separate-loading and fixed.

25. The possibility of a sticker round exists when charge 1 is being fired from the--

- a. 175-mm M107.
- b. 8-inch howitzer M110.
- c. 105-mm howitzer M102.
- d. 155-mm howitzer M109A1.

26. When a weapon fails to fire as a result of the failure of the primer or the firing mechanism, the malfunction is classified as a--

- a. cease fire.
- b. cook fire.
- c. misfire.
- d. sticker.

27. To prepare a superquick-delay, selective PD, impact fuze for delay action, you must first--

- a. set the selector setting sleeve to the horizontal position.
- b. rotate the fuze body to the proper setting.
- c. put a supplementary charge in the fuze well.
- d. move the interrupter out of the flash channel.

28. While a 155-mm howitzer (cold tube) is being fired, an ammunition malfunction occurs. Inspection of the primer indicates that the primer is dented and has fired. How long must you wait before you open the breech?

- a. 2 minutes.
- b. 5 minutes.
- c. 8 minutes.
- d. 10 minutes.

29. The type of fuze that has the capability of detonating the projectile in the air, at a predetermined height above the ground, is the--

- a.* superquick fuze.
- b.* concrete-piercing fuze.
- c.* proximity fuze (VT).
- d.* delay fuze.

30. If the MTSQ fuze is to be used for impact superquick action, the fuze must be set at--

- a.* 90.0.
- b.* 95.5.
- c.* 98.0.
- d.* 00.0.

31. The component of a round of ammunition that is most likely to cook off in a hot tube is the--

- a.* fuze.
- b.* booster.
- c.* projectile.
- d.* propellant.

32. An ammunition malfunction occurs while a 105-mm M101A1 is being fired. You find that the primer is not dented. You know that the cause of the malfunction is a defective--

- a.* powder charge.
- b.* firing mechanism.
- c.* primer.
- d.* igniting charge.

33. The fuze wrench used to seat and tighten a fuze into a standard HE projectile is the--

- a.* M16.
- b.* M63.
- c.* M26.
- d.* M27.

34. An ammunition malfunction occurs in a 105-mm howitzer (with a hot tube) that has been loaded for more than 5 minutes. How much time must be allowed for the weapon to cool before any attempt is made to remove the cartridge case?

- a.* 1 hour.
- b.* 2 hours.
- c.* 3 hours.
- d.* 4 hours.

35. The fuze setter that has a slip clutch in its handle that prevents the ring on a time fuze from being turned in a counterclockwise direction is the--

- a. M28.
- b. M34.
- c. M35.
- d. M63.

36. The threaded steel plug that facilitates the handling of separate-loading projectiles is called the--

- a. closing plug.
- b. nose plug.
- c. eyebolt lifting plug.
- d. fuze plug.

37. When the distant aiming point method of boresighting is used, the minimum distance between the aiming point and the weapon should be--

- a. 1,200 meters.
- b. 1,300 meters.
- c. 1,400 meters.
- d. 1,500 meters.

38. In boresighting by the testing target method, the testing target must be located at least _____ meters in front of the howitzer.

- a. 50
- b. 60
- c. 4 to 15
- d. 100

39. Excessive blow back around the breechblock may mean the split rings are less than 180° apart.

- a. True.
- b. False.

40. Fire control alinement tests should be performed--

- a. at the discretion of the battery commander.
- b. every 3 months when firing or once each year if no firing takes place.
- c. when fire is inaccurate for no apparent reason.
- d. all of the above.

QUESTIONS ON THE 105-MM HOWITZER M101A1

41. The two lugs on the bottom of the breech ring of the 105-mm howitzer M101A1 engage slots in the bottom rear of the sleigh to--

- a. lock the breech ring and tube to the cradle during firing.
- b. prevent the tube and breech ring from rotating during firing.
- c. act as bearing surfaces for the breech ring when it slides on the cradle.
- d. provide an accurate seat for the gunner's quadrant.

42. The pneumatic respirator on the 105-mm howitzer M101A1 will provide minimum counter-recoil buffing action when placed on a setting of--

- a. 0
- b. 1
- c. 2
- d. 3

43. The component of the 105-mm howitzer M101A1 that supports the overhanging weight of the barrel and breech assembly and recoil mechanism during travel is the--

- a. equilibrating mechanism.
- b. cradle lock strut.
- c. cradle traveling lock.
- d. spring equilibrator.

44. The traversing mechanism on the 105-mm howitzer M101A1 is the--

- a. arc and pinion type or bevel gear type.
- b. hydraulic piston type or recirculating ball type.
- c. rack and pinion type or arc and gear type.
- d. screw and nut type or rack and worm type.

45. The number of screw fillers of recoil oil that must be added to insure the proper amount of oil is in the oil reserve is--

- a. 1 1/4.
- b. 1 1/2.
- c. 1 3/4.
- d. 2.

46. On the M101A1, the sleigh with recoil mechanism is attached to the stationary cradle by the--

- a. piston rod outer locking nut.
- b. breech ring locking screw.
- c. front yoke of the sleigh.
- d. howitzer locking ring.

47. The maximum allowable backlash of the elevating handwheel on the M101A1 is--
- one-sixth of a turn.
 - one-third of a turn.
 - one-half of a turn.
 - three-fourths of a turn.
48. The recoiling parts of the M101A1 are held in the in-battery position by the force of the--
- compressed nitrogen in the recuperator cylinder.
 - compressed oil in the recoil cylinder.
 - compressed oil in the counterrecoil cylinder.
 - compressed spring in the equilibrator.
49. If the tube of the M101A1 slams into battery after firing, a possible cause is--
- insufficient nitrogen pressure.
 - insufficient oil reserve.
 - excessive oil reserve.
 - nitrogen in the recoil oil.
50. When the M101A1 is fired with maximum charge, the maximum allowable recoil is--
- 46 inches.
 - 44 inches.
 - 42 inches.
 - 40 inches.
51. The axle and support of the M101A1 are kept in alinement during equalizing action by the--
- pivot pin.
 - pintle pin.
 - gib bearings.
 - screw stops.

QUESTIONS ON THE 105-MM HOWITZER M102

52. The type of firing mechanism used on the M102 is the--
- firing lock M13.
 - firing mechanism M35.
 - inertia percussion mechanism.
 - percussion hammer mechanism.

53. The M102 recoil mechanism oil reserve should be reestablished when the oil index indicator rod protrudes as much as--(Select the MOST APPLICABLE choice.)

- a. three thirty-seconds of an inch.
- b. one-eighth of an inch.
- c. five thirty-seconds of an inch.
- d. three-sixteenths of an inch.

54. The means for raising and lowering the wheels of the M102 is provided by the--

- a. spring-loaded leveler.
- b. mechanical actuator.
- c. wheel assemblies.
- d. roller supports.

55. Though the function of the M114 elbow telescope (M102) is basically the same as that of other direct fire telescopes, it does differ in that it has--

- a. a fixed power capability.
- b. facilities for only a one-man, one-sight operation.
- c. a reticle presentation of multiple ballistic data.
- d. a reticle presentation of ballistic data for only one projectile and one charge.

56. The yoke that contains the recoil oil filling valve on the M102 is the--

- a. first yoke.
- b. second yoke.
- c. third yoke.
- d. fourth yoke.

57. The locking pin for the out-of-battery lock on the M102 is located on the--

- a. left side of the sleigh.
- b. right side of the sleigh.
- c. left side of the cradle.
- d. right side of the cradle.

58. The M102 is prevented from tipping forward during firing by the--

- a. buffer assembly.
- b. roller tire.
- c. box trail.
- d. firing stakes.

59. The breechblock of the M102 is locked in the open position by the--
- extractors.
 - torsion helical spring.
 - operating crank.
 - operating handle.
60. The variable recoil actuating mechanism of the M102 is a component of the--
- recoil mechanism.
 - sleigh.
 - cradle.
 - carriage.
61. The assembly on the M102 that prevents the carriage from tipping forward when the recoiling parts return to battery is the--
- respirator assembly.
 - buffer assembly.
 - regulator body assembly.
 - support assembly.
62. The knob on the panoramic telescope M113 (M102) that will simultaneously turn the sight rotating head, the reset counter digits, and the azimuth counter digits is the--
- reset counter knob.
 - gunner's aid counter knob.
 - elevation knob.
 - azimuth knob.

QUESTIONS ON THE 155-MM HOWITZER M109/M109A1

63. After the projectile has been properly positioned on the tray chute of the weapon-mounted rammer of the M109 howitzer, rotation of the rammer back into position on the tray chute is accomplished by use of the--
- main release handle.
 - cylinder release handle.
 - rammer shaft and cover.
 - actuator switch.
64. Hydraulic power for operating the cab traversing mechanism, the howitzer elevating mechanism, and the hydraulic rammer of the M109 is supplied by--
- a hydraulic pump powered by a 5-horsepower electric motor.
 - an auxiliary 110-volt motor generator set.
 - the 24-volt electric storage batteries.
 - a DC generator driven by the vehicle engine.

65. The cradle of the M109 is part of the--
- equilibrator system.
 - hydraulically operated traversing system.
 - howitzer mount M127.
 - recoil and counterrecoil system.
66. The equilibrator system of the M109 must be adjusted by increasing or decreasing the--
- length of the temperature adjusting screws.
 - tension in the equilibrator springs.
 - power to the electric motor driven hydraulic system pump.
 - pressure in the equilibrator system.
67. In the accumulator-replenisher system of the M109 the pressure in the nitrogen bladder must be checked and filled with the required amount of nitrogen while the hydraulic oil in the accumulator tank is static. The amount of pressure in the nitrogen bladder should be--
- 7 to 8 psi.
 - 10 to 12 psi.
 - 15 to 17 psi.
 - 21 to 24 psi.
68. If the M109 is not fired, the chamber evacuator valves should be removed and cleaned--
- daily.
 - weekly.
 - monthly.
 - semiannually.
69. To engage the high-speed manual traverse on the M109, the operator moves the MANUAL-POWER selector to the--
- right and the speed selector lever to the right.
 - right and the speed selector lever to the left.
 - left and the speed selector lever to the right.
 - left and the speed selector lever to the left.
70. When the M109 is fired, the counterrecoil buffer piston is moved rearward by--
- the breech ring band.
 - the buffer piston rod.
 - recoil oil pressure.
 - a compressed spring.

71. The number of rounds that can be carried in the ammunition racks in the M109/M109A1 is--
- 28.
 - 36.
 - 42.
 - 50.
72. The maximum rate of fire for the M109/M109A1 is--
- 1 round per minute for 3 minutes.
 - 2 rounds per minute for 4 minutes.
 - 3 rounds per minute for 4 minutes.
 - 4 rounds per minute for 3 minutes.
73. The zero pressure check on the M109/M109A1--
- is normally performed by an artillery mechanic.
 - indicates the amount of precharged nitrogen in the main accumulator.
 - indicates if there is sufficient hydraulic oil in the main powerpack reservoir.
 - all of the above.

QUESTIONS ON THE 155-MM HOWITZER M114/M114A1

74. The emergency air lines in the airbrake system of the M114A1 furnish air to--
- control all service brake operations.
 - control all automatic brake applications.
 - the top side of the emergency relay valve.
 - keep the air tank charged at all times.
75. One complete turn of the traversing handwheel of the M114A1 will move the tube--
- 10.3 mils.
 - 12.6 mils.
 - 14.8 mils.
 - 16.1 mils.
76. The proper amount of recoil oil reserve in the replenisher of the M114A1 will be indicated when the replenisher piston rod extends--
- 3 1/2 inches.
 - 5 1/2 inches.
 - 7 1/2 inches.
 - 9 1/2 inches.

77. The replenisher on the M114A1 contains the oil reserve for the--
- recuperator cylinder.
 - counterrecoil cylinder.
 - recoil cylinder.
 - counterbalance cylinder.
78. The tube of the M114A1 is prevented from twisting during firing by means of--
- lugs on the top and bottom of the breech ring.
 - the counterrecoil piston rod.
 - an integral and removable recoil guide key.
 - rear-mounted trunnion pins.
79. The elevating mechanism of the M114A1 is classified as the--
- worm and sector type.
 - recirculating ball type.
 - arc and pinion type.
 - rack and pinion type.
80. The proper volume of oil in the recoil mechanism system of the M114A1 is maintained at all times by action of the--
- floating piston.
 - recuperator.
 - replenisher.
 - variable recoil and cam assembly.
81. The M114A1 can be traversed _____ mils to the left from the center of traverse.
- 418.
 - 428.
 - 438.
 - 48.
82. The replenisher oil reserve on the M114A1 should be checked prior to firing and also--
- after firing.
 - after every 10 rounds fired.
 - after every 100 rounds fired.
 - upon completion of the first fire mission.

83. The obturator spindle of the M114A1 breech mechanism is retained in the breechblock by the--

- a.* firing mechanism housing.
- b.* firing mechanism housing adapter.
- c.* obturator spindle plug.
- d.* obturator spindle sleeve.

QUESTIONS ON THE 8-INCH SELF-PROPELLED HOWITZER M110

84. In boresighting the M110 with the elbow telescope M116, corrections in azimuth and elevation are made by--

- a.* changing the reticle in the telescope.
- b.* adjusting the elbow telescope mount M138.
- c.* adjusting the elevation quadrant M15.
- d.* moving the fine index on the telescope head.

85. The loader-rammer assembly of the M110 is operated by--

- a.* manual power only.
- b.* manual or electric power.
- c.* electrical or hydraulic power.
- d.* manual or hydraulic power.

86. The manual traverse control on the M110 is intended to be used only--

- a.* during two-man, two-sight direct firing.
- b.* as a backup in case of power failure.
- c.* to make final deflection settings during firing.
- d.* when the howitzer is within 2.0 mils of the desired deflection.

87. The recoil mechanism employed on the M110 is the hydropneumatic--

- a.* variable, independent type.
- b.* constant, independent type.
- c.* variable, dependent type.
- d.* constant, dependent type.

88. The counterbalance assembly of the M110 is a part of the--

- a.* loader-rammer assembly.
- b.* equilibrators assembly.
- c.* breech mechanism.
- d.* recoil mechanism.

89. The two recoil spade cylinders that raise or lower the recoil spade on the M110 are controlled by a lever located at the--

- a. left rear of the vehicle.
- b. right rear of the vehicle.
- c. gunner's seat position.
- d. assistant gunner's seat position.

90. To overcome friction buildup on the recuperator floating piston that has caused the recuperator oil index of the M110 to stick, it is necessary to--

- a. place the power takeoff switch in the ON position.
- b. position and hold the oil pump motor switch in the OVERRIDE position.
- c. place the retracting control valve handle in the RETURN position.
- d. notify support maintenance personnel.

91. The control for the fixed fire extinguisher system of the M110 is located in the--

- a. engine compartment.
- b. operator's compartment.
- c. battery compartment.
- d. turret well.

92. To reestablish the recuperator oil reserve of the M110, it is necessary to place the oil pump motor switch in the ON position and to place the retracting control handle in the--

- a. RETRACT position.
- b. NORMAL position.
- c. HOLD position.
- d. RETURN position.

93. The breechblock on the M110 is the--

- a. horizontal sliding-wedge type.
- b. vertical sliding-wedge type.
- c. interrupted-screw type with stepped threads.
- d. interrupted-screw type without stepped threads.

QUESTIONS ON THE 175-MM GUN, M107

94. The tube of the M107 will normally begin maximum recoil at _____ of elevation.

- a. 178 mils.
- b. 480 mils.
- c. 950 mils.
- d. 1,100 mils.

95. The engine-driven hydraulic pump, used to initially charge the accumulator of the hydraulic system of the M107, should not be operated--

- a.* in excess of 1,200 rpm.
- b.* for raising or lowering the spade.
- c.* to save the vehicle batteries.
- d.* when the vehicle is in motion.

96. The M107 is classified as a--

- a.* light field artillery weapon.
- b.* medium field artillery weapon.
- c.* heavy field artillery weapon.
- d.* very heavy field artillery weapon.

97. The nitrogen pressure within the equilibrators of the M107 may have to be increased to establish satisfactory handwheel loads if the temperature at the time of firing is--

- a.* below 0° F.
- b.* between 0° F and 32° F.
- c.* between 70° F and 110° F.
- d.* above 110° F.

98. The recuperator cylinder of the M107 is charged when the retracting control valve is placed in the--

- a.* RETRACT position.
- b.* NORMAL and HOLD positions.
- c.* OFF position.
- d.* RETURN position.

99. The number of lands and grooves in the rifling of the tube of the M107 is--

- a.* 24.
- b.* 36.
- c.* 48.
- d.* 64.

100. When electrical power from one M107 is used to start another M107, damage to the voltage regulator and rectifier of the vehicle being started can be prevented by--

- a.* reversing the polarity of the battery cables.
- b.* turning the master switch of the receiving vehicle to OFF.
- c.* using high-capacity jumper cables.
- d.* routing the incoming current around the batteries of the receiving vehicle.

101. The limits of elevation of the M107 are governed by--
- a. the solenoid valve circuit.
 - b. the elevating hydraulic control.
 - c. the elevating motor brake.
 - d. stops on the elevation arc.
102. The oil reserve for the recoil cylinder of the M107 recoil mechanism is contained in the--
- a. replenisher cylinder.
 - b. recuperator cylinder.
 - c. counterrecoil cylinder.
 - d. recoil cylinder.
103. The number of road wheel arms on the M107 with hydraulic lockout cylinders are--
- a. two.
 - b. four.
 - c. six.
 - d. eight.
104. The 300-ampere generator in the electrical system of the M107 is driven directly by the--
- a. auxiliary drive transfer unit.
 - b. 12-volt storage batteries.
 - c. vehicle engine.
 - d. 5-horsepower auxiliary engine.

QUESTIONS FOR VEHICLE DRIVERS

Directions: The items below are followed by several answers. Select the *best* answer for each test item, and mark the appropriate space on your answer sheet.

105. When preparing to go up a hill, a tracked vehicle driver should--
- a. always place the vehicle in the lowest range.
 - b. choose the range that will carry the vehicle over the hill.
 - c. leave the vehicle in the range it is in until the engine "lugs down," then shift to a low range.
 - d. always bring his vehicle to a complete stop, then place the selector in the lowest range until the hill is negotiated.
106. Most vehicle skids are the result of--
- a. vehicles operating on steel tracks.
 - b. vehicles operating on rubber tracks or pads.
 - c. vehicles operating on slippery, unsafe roads.
 - d. vehicles being driven too fast for the road surface conditions.

107. When a vehicle guide brings his hands together in front of him, he means--
- slow down.
 - stop your engine.
 - stop.
 - go straight ahead.
108. Unequal track tension will cause--
- no difference in riding qualities.
 - no difference in driving qualities.
 - the vehicle to jump or steer erratically.
 - the vehicle to lead to one side.
109. When one track is spinning, power can best be applied to the opposite track by--
- chaining the slipping track to a roadwheel arm.
 - applying steering control to the slipping track with the transmission in neutral.
 - applying steering action with the transmission in driving range.
 - moving the selector lever rapidly from drive to reverse range with the engine accelerated and applying no steering action.
110. When a vehicle approaches from the rear to pass, you should--
- be warned by the vehicle commander, keep to the right, and allow it to pass.
 - increase speed so that the vehicle will not pass.
 - disregard the vehicle until the next scheduled halt, when it can pass.
 - move to the right, halt, and motion the vehicle to pass.
111. If the red master warning light comes on while the vehicle is in operation, the driver should--
- ascertain the source of the trouble at the next scheduled halt.
 - proceed but inform the vehicle commander and let him investigate.
 - stop the vehicle immediately, determine the source of trouble, and then proceed.
 - disregard the light, as most warning panels do not function properly.
112. A throat-cutting motion with the right hand and arm by the vehicle guide is the signal for--
- cranking the engine.
 - increasing speed.
 - turning off headlights.
 - stopping the engine.

113. To cross a ditch or a small ravine, a track driver should--
- a. back off to get space for a maximum-speed approach and jump the vehicle over the ditch.
 - b. move slowly over the edge in low range, brake until the vehicle eases into the ditch, then accelerate enough to carry the vehicle up and over the other side.
 - c. move rapidly into the obstacle in high range at maximum engine rpm and maintain full acceleration until the obstacle is cleared.
 - d. move slowly to the edge of the ditch, then accelerate fully until the obstacle is cleared.
114. In crossing a soft field of mud or sand--
- a. follow in the tracks of the vehicle ahead (if applicable).
 - b. zigzag across the area as fast as possible.
 - c. move as straight and steadily as possible; do not track the vehicle ahead (if applicable).
 - d. stop and reverse the vehicle occasionally to remove the sand or mud from the tracks.

Directions: A series of true/false statements follows. If any part of a statement is false, the entire statement is false. Indicate your answer by marking the appropriate space on your answer sheet.

115. Before an engine is stopped, it should be cooled by idling for a period of time.
- a. True.
 - b. False.
116. Permitting vehicles to stand overnight with a low fuel level could result in water in the fuel.
- a. True.
 - b. False.
117. The best way to warm up an engine is to race it several times.
- a. True.
 - b. False.
118. It is not necessary to check for a hydrostatic lock in cold weather because gasoline does not vaporize easily at low temperatures.
- a. True.
 - b. False.
119. The use of indirect-vision devices by tracked vehicle drivers does not reduce their driving capability.
- a. True.
 - b. False.

120. It is permissible to start or operate a tracked vehicle without fire extinguishers present.

- a. True.
- b. False.

STATION IV

Task 1: Conduct A Deliberate Occupation Of A Prepared Position.

Task 2: Conduct A Hasty Displacement To A Supplementary Position.

Conditions

- Task 1 will be administered in two phases.

- a. Phase 1 will be the preparation of the position by the gun guide.
- b. Phase 2 will be the deliberate occupation and improvement of the position.

- Task 2 will be a hasty displacement to a supplementary position.

- The gun guide will be required to prepare a position for a deliberate occupation. Upon his arrival in position, the gun guide will be given a detailed briefing to include--

- a. The specific location for his howitzer.
- b. The direction of fire.
- c. The initial deflection from the aiming circle.

- d. The route into and through the simulated battery position area. Upon the completion of his briefing, he will be allowed 15 minutes in which to prepare the position.

- The section will be allowed 30 minutes to occupy and improve the position. Time for the occupation will start when the howitzer enters the battery area at a designated entrance point. Time will end when the section receives the mission to displace to its supplementary position. Camouflage nets will not be erected during the improvement of the position phase, because of time limitations at this station.

- The section chief will give all reports to the examiner, who will act as the executive officer for reporting purposes.

- The examiner will be provided a copy of the unit field SOP to use in evaluating selected procedures.

- Preparations will be made to lay the howitzers by wire.

Upon occupation of position, the examiner will inform the section chief of--

- his sectors of responsibility for direct fire for both the howitzer and secondary armament, as appropriate.

- his supplementary position within 100 meters of the howitzer position.

Task 1, Phase 1 Standards (Gun Guide)

The gun guide--

- Provided initial security for the simulated reconnaissance party in the position area.

- Had all the equipment required, according to the unit SOP, upon his arrival in the new position.

GO	NO GO

- ✓

[illegible]

For each NO GO rating, 0 points will be awarded.

1

-

[illegible]

- Each section member performed his duties with minimum orders.
- The collimator and aiming posts were prepared for use while the howitzer was being laid.
- The aiming posts were properly emplaced as time permitted.
- As the situation permitted, boresight was verified within 3 minutes (by DAP method).
- Site and range to crest were accurately reported.
- The section chief reported when his section was in order.
- Section gear was arranged according to unit SOP.
- All pertinent section data were recorded and posted as appropriate (laid deflection and deflection to aiming posts, collimator, and alternate aiming posts).
- The section was in the proper uniform throughout the occupation.
- Range cards were prepared for both the howitzer and the secondary armament, as appropriate.
- Operational checks and services were performed before, during, and after operation.
- The howitzer position was prepared for a 6,400-mil capability. (Optional)
- The section prepared a section data card for planned targets, which included target numbers, shell, lot, fuze, time, deflection, and quadrant.
- The section laid on the priority target within 15 seconds of the command from FDC.
- The section was continuously ready to respond (section members at their posts) and fired the weapon within 30 seconds of receiving the quadrant elevations from FDC.
- The section chief inspected and prepared a range card for his supplementary position.
- Section personnel had their individual NBC protective equipment and personal weapons immediately available.
- Section members donned their protective masks within 15 seconds (9 seconds without hoods) upon receipt of warning of an NBC attack.
- Proper alarm (unit SOP) and masking procedures were used by all section personnel.
- The section maintained track discipline and camouflaged exposed tracks.
- Reflective surfaces were covered.
- Noise and light discipline were maintained.

[illegible]

- Natural materials, when available, were used to help camouflage the section position.

- The howitzer and section area were neat and orderly.

- No conditions were allowed to exist that would make the howitzer unsafe during firing.

- Prefire checks were properly performed.

GO	NO GO

Phase 2. Scoring

For each GO rating, 5 points will be awarded.

For each NO GO rating, 0 points will be awarded.

Task 2, Hasty Displacement To Supplementary Position

Exactly 30 minutes from the time the section entered the primary position, they will be given a situation which will require them to displace to the supplementary position.

Standards

- The howitzer displaced within 30 seconds (M109/M109A1, M101A1) or 1 minute (M114, M107, M110, M102) after notification to displace to the supplementary position.

- The howitzer was ready to engage a direct fire target within 15 seconds (30 seconds, M114A1) after halting in the supplementary position. (Sights are on target; dummy ammunition, if available, is loaded.)

- The section engaged the target with the .50 caliber machinegun or individual weapons, as appropriate.

- The section chief assigned individual sectors of responsibility to his men in the supplementary position.

- During a simulated air attack in the supplementary position, the section members surveyed their assigned sectors of responsibility and the warning was sounded according to unit SOP.

GO	NO GO

Task 2 Scoring

For each GO rating, 7 points will be awarded.

For each NO GO rating, 0 points will be awarded.

Total Scoring Synopsis for Station IV:

Task	Possible Points	Earned Points
1 Phase 1	75	_____ GO ratings x 7.5 = _____
1 Phase 2	190	_____ GO ratings x 5 = _____
2	35	_____ GO ratings x 7 = _____
Total possible =	300	Total earned = _____

STATION V

Task 1: Hasty Occupation.**Conditions**

- The section will be required to execute a hasty occupation.
- The start point will be a point 100 meters from the simulated battery position.
- The howitzer will be laid by an examiner.
- Time for the task will start when the howitzer crosses the designated starting point and will end when the howitzer is ready to fire the initial round.
- When the howitzer was halted in position, the examiner will give the section chief a card listing the fire commands and firing data for the mission.
- Occupation will include--
 - a. *M110/M107--*
 1. Emplacement of spades (level firing platform).
 2. Establishment of oil reserve.
 3. Check of adjustment and timing of loader-rammer.
 - b. *M102--*Securing of firing platform with two stakes.
 - c. *M114/M114A1--*
 1. Properly attaching spades.
 2. Digging in spades.
 - d. *M101--*Emplacement of spades according to the unit SOP.
 - e. *M109/M109A1--*
 1. Proper emplacement of spades.
 2. Leveling of firing platform (no roadwheels off the ground).

Standards

	Possible Points	Penalty Points
•The howitzer is laid to an accuracy of 0 mils and all bubbles are centered.	20	-5 for each mil out of lay, unlevel bubble
•An aiming point is emplaced according to unit SOP.	15	-15 if not emplaced
•Commands for the mission are correctly stated by all section members.	10	-2 for each incorrect or omitted command.
•The howitzer fired the correct data.	20	-20 for any incorrect data
• <i>M110/M107--</i>	15	
1. Spades are properly emplaced.		-5 if not properly emplaced
2. Oil reserve is properly established.		-5 if not established

3. Loader-rammer is checked for adjustment and timing. -5 if not checked
- M102-- 15
Firing platform is secured with two stakes. -15 if not secured
- M114/M114A1-- 15
1. Spades are properly attached. -10 if not attached properly
2. Spades are dug in. -5 if not dug in
- M101A1-- 15
Spades are emplaced according to unit SOP. -15 if not properly emplaced
- M109/M109A1-- 15
1. Spades are properly emplaced. -10 if not properly emplaced
2. Level firing platform is insured. -5 if not a level platform or if roadwheels off ground

•The time to execute the mission will be scored according to the following:

Time (in minutes)

M114	M109/M109A1	M110/M107	M101	M102	Points
0 - 5:00	0 - 1:30	0 - 3:30	0 - 3:00	0 - 2:00	20
5:01 - 5:45	1:31 - 1:50	3:31 - 4:00	3:01 - 3:20	2:01 - 2:30	15
5:46 - 6:15	1:51 - 2:05	4:01 - 4:15	3:21 - 3:35	2:31 - 2:45	10
6:16 - 6:30	2:06 - 2:15	4:16 - 4:20	3:36 - 3:45	2:46 - 2:55	5
Longer than 6:30	Longer than 2:15	Longer than 4:20	Longer than 3:45	Longer than 2:55	0

Task 2: 6,400-Mil Mission.

Conditions

- The task will be executed from the hasty occupation position.
- The section will be given sufficient time to prepare the position for 6,400-mil capability.
- The section chief will be given a data card that will require the section to execute a shift in direction of a minimum of 3,000 mils. Time for the task will begin when the section chief gives the first word of the fire command and will end when the weapons are ready to fire.
- Dummy ammunition, if available, will be loaded into the howitzer.
- The section will be required to shift from its primary aiming point to the alternate aiming point.

Standards

	Possible Points	Penalty Points
•The howitzer is laid on the firing data to an accuracy of 0 mils and all bubbles are centered when checked by the examiner.	35	-5 for each mil out of lay or unlevel bubble
•The howitzer is traversed in the direction of the shortest deflection shift.	15	-15 if traversed in wrong direction
•Commands for the mission are correctly stated by all section members.	10	-2 for each incorrect or omitted command
•The speed of execution of the mission is scored according to the following:		

M101	M109/M109A1	M110/M107	M102	M114	Points
0 - 4:00	0 - 0:45	0 - 3:30	0 - 0:30	0 - 5:30	40
4:01 - 5:00	0:46 - 1:05	3:31 - 4:00	0:31 - 0:45	5:31 - 6:46	30
5:01 - 5:30	1:06 - 1:20	4:01 - 4:15	0:46 - 0:55	6:47 - 7:15	20
5:31 - 5:45	1:21 - 1:30	4:16 - 4:20	0:56 - 1:00	7:16 - 7:30	10
Longer than 5:45	Longer than 1:30	Longer than 4:20	Longer than 1:00	Longer than 7:30	0

Task 3: Indirect And Direct Laying.**Conditions** (Indirect Laying)

•This task will be administered immediately following the 6,400-mil mission.

•The section chief will be given five individual cards with the firing data for each round.

Example:

CARD 1

Section chief commands:

FIRE MISSION, BATTERY ADJUST, CHARGE 5, DEFLECTION 2938, QUADRANT 348.

CARDS 2 AND 3

Section chief commands:

DEFLECTION (so much), QUADRANT (so much).

•For tests 2 and 3, the size of the deflection and quadrant shifts from the last round fired will be--

Deflection: 20-40 mils.

Quadrant: 20-30 mils.

•For tests 4 and 5, high-angle fire will be required. The size of the deflection and quadrant shifts will be--

Deflection: 50-80 mils.

Quadrant: 900-1,000 mils.

The tube will be returned to loading elevation after each round is fired. The M107 gun will fire rounds 4 and 5 at low angle and will be graded at the low angle time standards.

•The time for each test will begin when the section chief states the first word of the command and will end when the number 1 cannoneer has fired the weapon.

•The cannoneers will perform all of the actions required to fire the weapon, to include using dummy ammunition, if available. Firing will be on the command of the section chief.

Standards (Indirect laying--20 points each round)

MAXIMUM POSSIBLE POINTS	ROUND	M109/ M109A1	M110/ M107	M114A1	M101	M102	PENALTY POINTS
4	1 2 and 3 4 and 5	18 sec 13 sec 20 sec	18 sec 13 sec 20 sec	18 sec 13 sec 25 sec	18 sec 13 sec 25 sec	18 sec 13 sec 25 sec	1 point for each second over

•All bubbles are exactly centered when round is fired.

-4 for any uncentered
bubble (max points, 4)

•Panoramic telescope is correctly alined on aiming point when round is fired.

-4 if not alined (max
points, 4)

•The correct data are fired.

-4 for any incorrect data
(max points, 4)

•Correct and complete fire commands are issued by all section members (SET, READY, CLOSE, etc.)

-1 for each incorrect or
omitted command (max
points, 4)

Conditions (Direct Laying)

•A stationary target will be emplaced a minimum of 800 meters from the howitzer to simulate a moving target.

•The section chief will be given a series of 3 by 5-inch cards that will require the section to use direct laying procedures.

•The two-man, two-sight system will be used by all sections except that the M114A1 will use the one-man, one-sight system.

•The following sample situation cards may be used for all weapons. The examiner should prepare situation cards that are varied and that avoid routine or similar ranges.

CARD 1

A Russian T62 tank is approaching your battery position and is moving straight toward your howitzer at an estimated range of 1200 meters.

CARD 2

The first round fired by your section went over the tank. The tank has now turned and is moving from left to right in front of your position at a speed of 25 mph and at the initial range of 1,200 meters.

CARD 3

The second round fired by your section was short of the tank and on line. The tank has turned again and is now moving from right to left at a 45° angle going away from your position at a speed of 20 mph.

CARD 4

The tank was hit by your third round but was only partially disabled. You now desire to completely disable the tank and decide to fire on it using the ricochet technique.

Standards (Direct Laying-25 Points Each Round)

MISSION NUMBER	POSSIBLE POINTS	STANDARD	PENALTY
1	5	The section chief issues correct and complete fire commands within 20 seconds of the receipt of each card and section members announce correct commands.	-1 for each incorrect or omitted fire command or each command which takes over 20 seconds to issue.
2	8	The announced lead and range or elevation are set off.	-8 for any incorrect lead or range/elevation.
3	7	All bubbles are centered when the howitzer is fired.	-2 for each unlevel bubble
4	5	The time from the last digit of range/elevation until the howitzer is fired is 10 seconds or less.	-1 for each second over 10

STATION VI

Task: Perform Two Selected Tasks.

Conditions

The examiner will select two tasks from the following list. A different mix of tasks will be selected for each howitzer section prior to the beginning of the evaluation. Each task specifies the applicable conditions and standards.

TASK A: Provide Individual CBR Protection.

TASK B: Perform First Aid.

TASK C: Erect Camouflage Net.

TASK D: Lay the Piece for Direction with an Aiming Circle.

TASK E: Check and Adjust the Headspace and Timing on the .50 Caliber Machinegun.

TASK F: Disassemble and Assemble the M60 Machinegun.

TASK G: Disassemble and Assemble the M16A1 Rifle.

TASK H: Perform a Crater Analysis.

Task A: Individual CBR Protection.

Conditions

•The examiner will select two section members, other than the chief of section, to perform the task.

•Section members will have their individual M17A1 protective masks.

Standards

•Individuals mask within 9 seconds (without hoods) (15 seconds with hoods) of alarm.

GO	NO GO

- Individuals are proficient in individual protective measures for--
 - a. Chemical attack.
 - b. Biological attack.
 - c. Radiological attack.
- Section members are proficient in procedures for decontamination of--
 - a. Individual and personal equipment.
 - b. Section equipment.
- Each section member selected must be proficient in each standard for the section to receive credit for the standard.
- For each GO rating 5 points will be awarded.

GO	NO GO

Score = _____ GO ratings x 5 = _____

Task B: Perform First Aid.

Conditions

- The examiner will select two section members, other than the section chief, to perform the task.
- The section will have sustained casualties as a result of an enemy attack.

Standards

- Section first aid kits are readily available.
- Individuals possess individual first aid packets.
- Field dressings and bandages are properly applied.
- Immediate lifesaving measures are properly administered to--
 - a. Provide artificial respiration.
 - b. Treat for bleeding.
 - c. Treat for shock.
 - d. Protect the wound.
- Section members are proficient in use of individual first aid packets.
 - a. Compress bandage.
 - b. Saline solution.
- For each GO rating 3 points will be awarded.

GO	NO GO

Score = _____ GO ratings x 5 = _____

Task C: Erect Camouflage Net.

Conditions

- The section will have occupied a deliberate firing position and will have completed all preparations for firing (simulated).

- The camouflage net and assorted equipment will be stowed in its normal location according to the section loading plan.

- The section will be formed to the rear of the piece prior to the start of the task.

- The camouflage net will be erected according to unit SOP.

- The time for the task will be adjusted by the examiner on the basis of the type of camouflage net system available to the unit. The time standards will be established prior to the conduct of the task.

Standards

- Section members function without orders.
- The net is erected according to unit SOP.
- The net is erected so as not to impede high-angle capability.
- The net is erected within the following time frame:

GO	NO GO

Note. This time frame is offered for example only. Units must establish these criteria prior to the start of the task, because the times will depend on the type of net and weapon.

New Camouflage System (Radar Scattering)

Points

0 - 10:00	10
10:01 - 15:00	8
15:01 - 17:00	6
17:01 - 18:00	4
18:01 - 18:30	2
Longer than 18:30	0

- For each GO rating 3 points will be awarded. Total points for that task will be determined as follows:

$$\begin{aligned}
 &\text{_____ GO ratings} \times 3 = \text{_____} \\
 &+ \text{_____ Points for time} = \text{_____} \\
 &\text{TOTAL} = \text{_____}
 \end{aligned}$$

Task D: Lay The Piece For Direction With An Aiming Circle.

Conditions

- The examiner will select the gunner or the section chief to perform the task.
- The examinee will be provided--
 - a. A declinated M2 aiming circle.
 - b. A piece oriented generally on the azimuth of fire.
 - c. The azimuth of fire.
 - d. The method of laying to be used and other information necessary according to the method.
- The examinee will perform the duties of the chief of firing battery and will be assisted by a gunner. The section assistant gunner will perform the duties of the gunner.

Standards

- The aiming circle is properly set up and leveled.
- The 0-3200 line of the aiming circle is properly oriented in the direction of fire.
- The proper commands and procedures are used in laying the piece to an accuracy of 0 mils.
- The aiming circle is properly prepared for use and the howitzer is laid within the following time framework:

GO	NO GO

Time	Points
0 - 2:30	10
2:31 - 3:00	8
3:01 - 3:15	6
3:16 - 3:25	4
3:26 - 3:30	2
Longer than 3:30	0

- The score for the task will be determined by the following:

$$\begin{array}{r}
 \text{_____ GO ratings} \times 5 = \text{_____} \\
 + \text{_____ Points for time} = \text{_____} \\
 \text{TOTAL} \quad \text{_____}
 \end{array}$$

Task E: Check And Adjust The Headspace And Timing On The .50 Caliber Machinegun.

Conditions

- The examiner will select one section member, other than the section chief, to perform the task.
- The machinegun will be adjusted out of correct headspace and timing prior to the start of the task.
- The examinee will be provided an assistant to perform duties as directed.
- No reference materials or other assistance will be allowed during the task.
- The barrel will be removed from the machinegun prior to the start of the task.

Standards

- The headspace is properly checked and set.
- The timing is properly checked and set.
- The time required to perform the task is within the following time framework:

GO	NO GO

Time	Points
0 - 4:00	9
4:01 - 4:30	8
4:31 - 4:50	6
4:51 - 5:00	4
5:01 - 5:05	2
Longer than 5:05	0

- The score for the task will be determined as follows:

$$\begin{array}{r} \text{_____ GO ratings} \times 8 = \text{_____} \\ + \text{_____ Points for time} = \text{_____} \\ \text{TOTAL} \quad \text{_____} \end{array}$$

Task F: Disassemble And Assemble The M60 Machinegun.

Conditions

- If applicable, the section will provide its own machinegun.
- The examiner will select two section members, other than the section chief, to perform the task.
- The machinegun will be field stripped and reassembled according to the procedures in the TM.

Standards

- The machinegun is properly disassembled.
- The machinegun is properly reassembled.
- The time required to perform the task is within the following framework:

GO	NO GO

Time	Points
0 - 3:00	9
3:01 - 4:00	8
4:01 - 4:30	6
4:31 - 4:45	4
4:46 - 4:55	2
Longer than 4:55	0

- The score for the task will be determined as follows:

$$\begin{array}{r} \text{_____ GO ratings} \times 8 = \text{_____} \\ \text{_____ Points for time} = \text{_____} \\ \text{TOTAL} \quad = \text{_____} \end{array}$$

Task G: Disassemble and assemble the M16A1 rifle.

Conditions

- Three section members will be selected to perform the task.
- Three individual rifles will be completely disassembled and reassembled according to the procedures prescribed in the TM.

Standards

- Each weapon is correctly disassembled.
- Each weapon is correctly reassembled.
- The time required to perform the task is within the following

GO	NO GO

framework:

Time	Points
0 - 3:00	9
3:01 - 3:45	8
3:46 - 4:15	6
4:16 - 4:30	4
4:31 - 4:40	2
Longer than 4:40	0

- The score for the task will be determined as follows:

_____ GO ratings x 8 = _____

_____ Points for time = _____

TOTAL = _____

Task H: Perform a Crater Analysis.

Conditions

- The examiner will select the chief of section and one other section member to perform the task.
- The examiner will construct a crater of a type of his own choosing and, if available, plant shell fragments corresponding to the type of crater.
- An enemy shell will have impacted in the battery area.

Standards

- Grid location of the crater is determined to within 100 meters.
- Direction of incoming rounds is determined within 5 minutes of arrival in area of impact.
- Direction to the firing weapon is determined to ± 60 mils.
- Shell fragments are collected and identified by the type of weapon firing (if applicable).
- SHELREP is completed and transmitted to the examiner within 10 minutes of impact of round.
- For each GO rating 5 points will be awarded.

GO	NO GO

RECOMMENDED GRADING SHEET HOWITZER SECTION EVALUATION

UNIT _____ SECTION _____ DATE _____

SECTION CHIEF	_____	No. 3 CANNONEER	_____
GUNNER	_____	No. 4 CANNONEER	_____
ASSISTANT GUNNER	_____	No. 5 CANNONEER	_____
No. 1 CANNONEER	_____	DRIVER	_____
No. 2 CANNONEER	_____	M548 DRIVER	_____

STATION II**Task 1 (End-for-End Test):****Points earned**

- | | | | |
|-------------------------|--------------|---|--------------|
| 1. Any NO GO's awarded? | Yes | = | 0 points |
| 2. If all GO's awarded: | Time = _____ | = | _____ points |

Task 2 (Micrometer Test):

- | | | | |
|-------------------------|--------------|---|--------------|
| 1. Any NO GO's awarded? | Yes | = | 0 points |
| 2. If all GO's awarded: | Time = _____ | = | _____ points |

Task 3 (Boresighting):

- | | | | |
|-------------------------|--------------|---|--------------|
| 1. Any NO GO's awarded? | Yes | = | 0 points |
| 2. If all GO's awarded: | Time = _____ | = | _____ points |

Task 4 (Breechblock):

- | | | | |
|---|--------------|---|--------------|
| 1. a. Any NO GO's awarded? | Yes | = | 0 points |
| b. If all GO's awarded: | Time = _____ | = | _____ points |
| 2. 10 points - (_____ errors x 2 = _____) | | = | _____ points |
| 3. a. Any NO GO's awarded? | Yes | = | 0 points |
| b. If all GO's awarded: | Time = _____ | = | _____ points |
| 4. 10 points - (_____ errors x 2 = _____) | | = | _____ points |

TOTAL = _____

STATION III**Task 1: (Organizational Maintenance Inspection):**

- 20 possible points (howitzer) - (_____ deficiencies x 1 point each = _____) = _____ points.
- 5 possible points (howitzer logbook) - (_____ deficiencies x 1 point each = _____) = _____ points.
- 20 possible points (M548/PM)- (_____ deficiencies x 1 point each _____) = _____ points.
- 5 possible points (PM/M548 logbook)-(_____ deficiencies x 1 point each _____) = _____ points.

TOTAL TASK 1 = _____ points

Task 2: (Written/Oral Examination):

1. Section member scores:

Gunner	_____ /20 correct
Assistant gunner	_____ /20 correct
No. 1	_____ /20 correct
No. 2	_____ /20 correct
No. 3	_____ /20 correct
No. 4	_____ /20 correct
No. 5	_____ /20 correct

(Add other personnel as required)

Driver	_____ /20 correct
PM driver	_____ /20 correct

2. Section average = _____ /20 correct

3. Section average _____ x 2.5 = _____ points.

STATION III SUMMARY

Task 1 _____ points
 Task 2 _____ points
 TOTAL = _____ points

STATION IV

Phase 1 _____ GO ratings x 7.5 = _____
 Phase 2 _____ GO ratings x 5.0 = _____
 Phase 3 _____ GO ratings x 7.0 = _____
 TOTAL = _____

STATION V

Task 1 (Hasty Occupation):

Standard	Possible	Penalties	Earned
1	20	—(_____ errors x 5 = _____)	= _____
2	15	—(0 if emplaced, 15 if not emplaced)	= _____
3	10	— (_____ errors x 2 = _____)	= _____
4	20	— (0 if all correct, 20 for any error)	= _____
5	15	— (by weapon _____)	= _____
6	20	—(Time = _____ = _____ points)	= _____
TOTAL POINTS			_____

Task 2 (6400 Mil Mission):

Standard	Possible	Penalties	Earned
1	35	—(_____ errors x 5 = _____)	= _____
2	15	—(0 if right, 15 if wrong direction)	= _____
3	10	— (_____ errors x 2 = _____)	= _____
4	40	—(time = _____ = _____ points)	= _____
TOTAL POINTS			= _____

Task 3 (Indirect Laying):

ROUND 1

Standard	Time of Execution	Possible	Penalties	Earned
1		4	— (_____ sec over x 1 pt = _____)	= _____
2		4	— (0 if all bubbles level, 4 for any unlevel bubble)	= _____
2		4	— (0 if alined, 4 if not alined)	= _____

4	4	— (0 if all data correct 4 if incorrect data)	= _____
5	4	— (_____ errors x 1 pt = _____)	= _____
TOTAL POINTS			= _____

ROUNDS 2-5

Standard	Time of Execution	Possible	Penalties	Earned
1		4	— (_____ secs over x 1 pt = _____)	= _____
2		4	— (0, if all bubbles level, 4 for any unlevel bubble)	= _____
3		4	— (0 if alined, 4 if not alined)	= _____
4		4	— (0 if all data correct, 4 if any incorrect data)	= _____
5		4	— (_____ errors x 1 pt = _____)	= _____
TOTAL POINTS				= _____

Indirect Laying Summary

Round 1 = _____

Round 2 = _____

Round 3 = _____

Round 4 = _____

Round 5 = _____

Total = _____ points

Task 3 (Direct Laying):

ROUND 1

Standard	Time	Possible	Penalties	Earned
1		5	— (_____ sec over 20 sec x 1 pt = _____)	= _____
2		8	— (0 if all data correct 8 for any data incorrect)	= _____
3		7	— (_____ errors x 2 points = _____)	= _____
4		5	— (_____ sec over 10 sec x 1 pt = _____)	= _____
TOTAL POINTS				= _____

ROUNDS 2-4

Standard	Time	Possible	Penalties	Earned
1		5	— (_____ sec over 20 sec x 1 pt = _____)	= _____
2		8	— (0 if all data correct, 8 for any data incorrect)	= _____
3		7	— (_____ errors x 2 points = _____)	= _____

4

5

— (_____ sec over 10 x 1 pt = _____) = _____

TOTAL POINTS _____

Direct Laying Summary:

Round 1 = _____

Round 2 = _____

Round 3 = _____

Round 4 = _____

TOTAL = _____

Task 3 Summary:

Indirect laying = _____

Direct laying = _____

TOTAL = _____ points

STATION V SUMMARY

Task 1 = _____

Task 2 = _____

Task 3 = _____

Total = _____ Points

STATION VI

Task (A-H) = _____

Task (A-H) = _____

TOTAL = _____ points

Evaluation Summary

Station II _____

Station III _____

Station IV _____

Station V _____

Station VI _____

TOTAL _____ points

CIRCLE ONE**Unsatisfactory****Satisfactory****Excellent****Outstanding****Distinguished**

(0 - 699)

(700 - 799)

(800 - 899)

(900 - 950)

(951 - 1000)



1
2
3
4



5
6
7
8



APPENDIX C

TEST FOR THE QUALIFICATION OF GUNNERS

Section I. GENERAL

Purpose and Scope

This appendix prescribes the tests to be given in the qualification of gunners. It applies to all weapons. The purposes of the tests are--

- To provide a means of determining the relative proficiency of the individual field artillery soldier in his performance of the principal duties of the gunner. It also tests the soldier in specified duties of the chief of section and assistant gunner that the gunner is expected to perform when called upon to do so. The tests can be used as a basis for award of clasps for the marksmanship badge and, as such, serve to bolster the esprit and motivation of the soldier. The tasks will NOT, however, be a basis for determining the relative proficiency of batteries or higher units.

- To serve as a supplement to training.

Standards of Precision

The examinee will be required to perform the tasks in accordance with the standards listed below.

- Settings must be exact.

- Bubbles inside leveling vials must be centered exactly.

- The vertical crosshair of the reticle of the panoramic telescope must be aligned exactly on the left edge of the aiming post or the 0 line of the collimator or on exactly the same part of the designated aiming point each time the piece is laid.

- Final motion of the elevation handwheel and the azimuth setting knobs must be in a clockwise direction.

- The appropriate deflection correction must be set on the gunner's aid.

Assistance

The examinee will receive no unauthorized assistance but will be provided an assistant as authorized for a specific task. If the examinee fails any task because of the fault of the examiner or an assistant, that task will be disregarded and the examinee will be given another test of the same nature.

Time

The time for any task will be the time from the last word of the command from the examiner to the last word of the appropriate report or the word *ready* from the examinee. The examinee may begin any test after the first word of the first command and should not be charged for any time used by the examiner.

Scoring

Scoring will be conducted in accordance with the standards for each task. No credit will be given if any of the general standards of precision or the standards of a specific test are not met.

PREPARATION FOR TESTS

The piece will be prepared for action and the examinee posted at the proper position according to the task being conducted or as indicated in the conditions of the task. The examiner will insure that the examinee understands the requirements of each task and will require him to report *I Am Ready* before each task.

Qualification Scores

Minimum scores required for qualification of the gunner are as follows:

Individual Classification	Points
Expert Gunner	90
Gunner First Class	80
Gunner Second Class	70

OUTLINE OF TEST

TASK NO.	SUBJECT	Number of Tasks	Points Each	Maximum Credit
1	Direct Laying, Panoramic Telescope	4	4	16
2	Reciprocal Laying With Panoramic Telescope and Aiming Circle	1	4	4
3	Alinement of Collimator	1	4	4
4	Alinement of Aiming Posts	1	4	4
5	Measuring Site to Crest	1	4	4
6	Performing Micrometer Test of Gunner's Quadrant	1	4	4
7	Performing End-for-End Test of Gunners Quadrant	1	4	4
8	Boresighting the Howitzer	1	4	4
9	Indirect Laying, Deflection Only	6	4	24
10	Correcting for Displacement with Aiming Posts	1	4	4
11	Correcting for Displacement with the Collimator	1	4	4
12	Laying for Quadrant with the Elevation Scale	1	4	4
13	Laying for Quadrant with the Gunner's Quadrant	2	4	8
14	Breechblock Disassembly	1	4	4
15	Breechblock Assembly	1	4	4
16	Howitzer Lubrication	1	4	4

Section II. TESTS

Task 1. Direct Laying, Panoramic Telescope

Using the panoramic telescope for direct laying, execute a series of four commands given by the examiner.

Conditions

- Two stationary targets will be placed approximately 600 meters from the howitzer. The targets should be separated by at least 50 meters.
- The azimuth counter will be set to 3,200 mils (or the azimuth and micrometer scales will be set to 0) and the gunner's aid will be set to 0.
- The howitzer will be oriented so that a 100-mil shift is required, but the motor carriage or trails will not have to be shifted in order to engage the stationary targets.
- The examinee will be posted as the gunner. The two-man, two-sight system will be used (two-man, one-sight for the M114A1 howitzer).
- An assistant will be provided to lay the piece for range (quadrant on the M114A1) and to center the cross-level vials.

COMMAND NUMBER 1: TARGET: THAT TANK, LEAD RIGHT 10, RANGE 800.
(For the M114A1, replace RANGE 800 with QUADRANT 16.)

Standards

- M100-SERIES SIGHT. Examinee sets the lead on the azimuth counter, traverses the tube until the vertical reticle is on the center of the target mass, centers the pitch and cross-level bubbles, steps clear, and commands, *FIRE*.
- M12-SERIES SIGHT. Examinee traverses the tube until the proper lead has been set, places the horizontal line of the reticle on the center of the visible mass of the target, steps clear, and commands, *FIRE* (for the M114A1, after the assistant announces SET).

Time in Seconds

Points

5.0 or less	4.0
5.1 to 6.0	3.0
6.1 to 7.0	2.0
7.1 or more	0.0

COMMAND NUMBER 2: RIGHT 10, DROP 200. (For M114A1, change DROP 200 to DROP 7.)

Standards

- M100-SERIES SIGHT. Examinee sets off the change in lead by using the click sight, traverses the tube until the vertical reticle is on the center of the target, steps clear and commands *FIRE*.
- M12-SERIES SIGHT. Examinee traverses the tube until the change in lead has been taken up with the vertical reticle, steps clear, and commands *FIRE* (for the M114A1, after the assistant announces SET).

Time in Seconds	Points
5.0 or less	4.0
5.1 to 6.0	3.0
6.1 to 7.0	2.0
7.1 or more	0.0

(For commands 3 and 4, the second of the two targets will be utilized.)

COMMAND NUMBER 3: TARGET: THAT TANK, LEAD LEFT 5, RANGE 600.

(For the M114A1, replace RANGE 600 with QUADRANT 9.)

Standards

- M100-SERIES SIGHT. Same as for command number 1.
- M12-SERIES SIGHT. Same as for command number 1.

Time in Seconds	Points
5.0 or less	4.0
5.1 to 6.0	3.0
6.1 to 7.0	2.0
7.1 or more	0.0

COMMAND NUMBER 4: LEFT 10, ADD 200. (For M114A1, change ADD 200 to ADD 7.)

Standards

- M100-SERIES SIGHT. Same as for command number 2.
- M12-SERIES SIGHT. Same as for command number 2.

Task 2. Reciprocal Laying with Panoramic Telescope and Aiming Circle

With an aiming circle, lay the howitzer reciprocally to 0 mils.

Conditions

- The howitzer will be prepared for action.
- An aiming circle will be located in an easily seen location within 50 meters of the howitzer and will be manned by an assistant examiner.
- The aiming circle will be oriented on a direction of fire that will not necessitate movement of the motor carriage or shifting of trails.

•The assistant examiner commands NUMBER 1, DEFLECTION _____

Standards

- The examinee sets the announced deflection on the panoramic telescope and traverses the howitzer until his line of sight through the telescope is on the aiming circle. He checks to insure that the bubbles are centered and announces NUMBER 1, READY FOR RECHECK

•As additional deflections are announced by the assistant examiner, the examinee sets them off on the panoramic telescope and traverses the tube so that the vertical reticle of the panoramic telescope bisects the lens of the aiming circle. The task is completed when the difference between the readings on the piece and the aiming circle is 0 mils. Bubbles on the panoramic telescope must be centered.

Time in Seconds	Points
30.0 or less	4.0
30.1 to 40.0	3.0
40.1 to 50.0	2.0
50.1 or more	0.0

Task 3. Alinement of Collimator

Emplace and aline a collimator.

Conditions

•The piece will have been laid for direction. An assistant, a prescribed deflection, and a collimator will be provided.

Standards

•Using the azimuth counter, the examinee rotates the head of the panoramic telescope to a prescribed deflection. The examinee directs the assistant to emplace the collimator so that 3 numbers can be seen in the reticle pattern.

•By use of the cylindrical cross-level vial and the azimuth and the elevation clamping knobs, the examinee directs the assistant to aline the collimator with the panoramic telescope so that there is no initial displacement.

Time in Seconds	Points
120 or less	4.0
More than 120	0.0

Task 4. Alinement of Aiming Posts

Emplace and aline aiming posts.

Conditions

•The howitzer will have been laid for direction.

•An assistant with a set of aiming posts will be provided. A prescribed deflection will also be provided.

•The aiming posts will be positioned at 50 and 100 meters prior to start of the test.

Standards

•Using the azimuth counter, the examinee rotates the head of the panoramic telescope to the prescribed deflection for the weapon and directs his assistant to emplace the far aiming post so that its left edge lines up with the vertical crosshair of the sight reticle.

•The examinee then directs his assistant to emplace the near aiming post at a distance one-half that of the far aiming post so that the left edge of the near aiming post is in alinement with the vertical crosshair of the telescope and the left edge of the far aiming post.

Time in Seconds	Points
120 or less	4.0
More than 120	0.0

Task 5. Measuring Site to Crest

Measure the site to crest.

Conditions

- The howitzer, prepared for action, will be placed within 1,000 meters of a crest of reasonable height.
- The tube will be elevated 100 to 150 mils above the crest and 100 to 150 mils to the right or left of the highest point on the crest.
- The examinee will be posted at the rear of the breech.
- An assistant will traverse and elevate the tube as directed by the examinee.

Standards

The examinee--

- Sights along the lowest element of the bore and directs movement of the tube until the line of sight just clears the highest point of the crest.
- Centers the cross-level and pitch-level bubbles on the elevation quadrant.
- Reads the elevation from the elevation counter (elevation scale for M12-series sight).
- Announces **NUMBER 1, SITE TO CREST _____ MILS.** The site to crest measured by the examinee must be within 5 mils of that measured by the examiner.

Time in Seconds	Points
15	4
16	3
17	2
18	1

Task 6. Performing Micrometer Test of Gunner's Quadrant

Perform the micrometer test of the gunner's quadrant.

Conditions

- The howitzer will be prepared for action. The trunnions will be level.
- The examinee will be provided an assistant to elevate or depress the tube.

Standards

- The examinee performs the test and states **QUADRANT MICROMETER IS (IS NOT) IN ERROR.**

Time in Seconds	Points
60 or less	4.0
More than 60	0.0

Task 7. Performing Gunner's Quadrant End for End Test

Perform the end-for-end test of the gunner's quadrant.

Conditions

- The howitzer will be prepared for action. The trunnions will be level.
- The examinee will be provided an assistant to elevate or depress the tube.

Standards

•The examinee performs the test and states CORRECTION _____ MILS. QUADRANT SERVICEABLE (UNSERVICEABLE). (The bubbles on the gunner's quadrant must be centered. This will be verified by the examiner.)

•The examinee declares the gunner's quadrant unserviceable if the error (one-half of the angle that was indicated when the quadrant was first reversed and the bubble was centered by use of the index arm and the micrometer knob) is greater than ± 0.4 mil.

Time in Seconds

Points

120 or less

4.0

More than 120

0.0

Task 8. Boresighting the Howitzer

Boresight the howitzer.

Conditions

- The howitzer will be prepared for action.
- The trunnions will be level.
- The examinee will be provided with an assistant to position a testing target on a stand in front of the howitzer.
- The examinee will be provided with a serviceable gunner's quadrant (end-for-end test has been performed and the examinee knows the correction), breech boresight, muzzle boresight and necessary screwdrivers.

Standards

- Using the gunner's quadrant, the examinee levels the tube.
- He centers the elevation and cross-level vials on the panoramic telescope mount and the elevation quadrant (if applicable), and he insures that all numerical counters on the elevation quadrant read 0 (on the M12-series sight, the elevation reading on the panoramic telescope mount must be 0).
- Using the muzzle and breech boresight and the testing target with stand, the examinee aligns the appropriate diagram of the testing target with the line of sight through the tube.
- The tube should not have been moved by the examinee.
- On the M12 series sight, the examinee sets the azimuth scale to 0 mils. Using the elevation knob of the sight and the tangent locking screws, he adjusts the vertical line of the panoramic telescope reticle precisely on the left aiming diagram of the testing target.
- On the M100-series sight, the examinee adjusts the azimuth and elevation knobs on the panoramic telescope to lay the reticle precisely on the left aiming diagram of the testing target.

The azimuth counter should read 3,200 mils. If it does not, he depresses and turns the boresight adjustment shaft until 3200 appears in the counter window.

- The bubbles of the panoramic telescope mount must be centered.

Time in Minutes	Points
3 or less	4.0
More than 3	0.0

Task 9. Indirect Laying, Deflection Only

Using indirect laying, execute a series of six commands given by the examiner.

Conditions

- A howitzer will be prepared for action and aiming posts or a collimator will be set out.
- The commands will not necessitate movement of the motor carriage or a shifting of trails.
- A suitable alternate aiming point will be identified to the examinee.
- Actions taken as a result of each command will be graded separately.
- The piece will be laid with the correct settings at the conclusion of each test before the examinee proceeds to the next test.
- The examiner will designate the section number of the howitzer to be used and will announce, when applicable, special corrections in deflection to be applied by the examinee.
- The examinee will be posted as the gunner.
- COMMAND NUMBER 1: SPECIAL CORRECTIONS, NUMBER 1, LEFT 7, DEFLECTION 3290.** (For M101A1, use DEFLECTION 2890. For M114A1, use DEFLECTION 2490.)

Standards

The examinee--

- Sets the deflection and applies special corrections to the gunner's aid.
- Centers the cross-level and pitch-level bubbles on the panoramic telescope mount.
- Traverses the howitzer until the vertical line on the panoramic telescope reticle is on the left edge of the aiming post or until the proper collimator sight picture appears. The examinee then--
 - a. Checks centering of the bubbles.
 - b. Re-lays the howitzer if necessary.
 - c. Announces READY when the action is completed.

Time in Seconds	Points
13.0 or less	4.0
13.1 to 14.0	3.0
14.1 to 15.0	2.0
15.1 or more	0.0

COMMAND NUMBER 2: DEFLECTION 3050. (For M101A1, use DEFLECTION 2650. For M114A1, use DEFLECTION 2250.)

Standards

The examinee--

- Sets the deflection.
- Leaves the corrections on the gunner's aid.
- Lays on the aiming posts or collimator.
- Checks the centering of the bubbles.
- Re-lays the howitzer if necessary.
- Announces READY when the action is completed.

Time in Seconds	Points
8.0 or less	4.0
8.1 to 9.0	3.0
9.1 to 10.0	2.0
10.1 or more	0.0

COMMAND NUMBER 3: NUMBER 1, RIGHT 4.

Standards

The examinee--

- Sets right 4 on the gunner's aid.
- Lays on the aiming posts or collimator.
- Checks the centering of the bubbles.
- Re-lays the howitzer if necessary.
- Announces READY when the action is completed.

Time in Seconds	Points
8.0 or less	4.0
8.1 to 9.0	3.0
9.1 to 10.0	2.0
10.1 or more	0.0

•UNGRADED: Examiner commands END OF MISSION. The examinee sets the gunner's aid to 0.

COMMAND NUMBER 4: AIMING POINT, CHURCH STEEPLE (or some other distant aiming point), REFER.

Standards

•The examinee turns the panoramic telescope to the church steeple and alines the reticle pattern on a straight vertical portion of the steeple.

•M100-SERIES SIGHT: The examinee uncovers the azimuth counter, reads the deflection and calls NUMBER 1, DEFLECTION.

•M12-SERIES SIGHT: The examinee reads the deflection on the nonslipping azimuth scale and announces NUMBER 1, DEFLECTION.

Time in Seconds	Points
8.0 or less	4.0
8.1 to 9.0	3.0
9.1 to 10.0	2.0
10.1 or more	0.0

COMMAND NUMBER 5: DEFLECTION 3200, REFER. (For M101A1, use DEFLECTION 2800, REFER. For M114A1, use DEFLECTION 2400, REFER.)

Standards

•M100-SERIES SIGHT. The examinee pushes in and rotates the reset counter knob until the reset counter reads 3200.

•M12-SERIES SIGHT. The examinee loosens the azimuth slipping scale, rotates it to 2800 for the M101A1 or 2400 for the M114A1, and then tightens the slipping scale. The door to the nonslipping azimuth scale is closed.

•The examinee calls NUMBER 1, DEFLECTION 3200 (for M101A1, 2800; for M114A1, 2400), and steps clear.

Time in Seconds	Points
13.0 or less	4.0
13.1 to 14.0	3.0
14.1 to 15.0	2.0
15.1 or more	0.0

COMMAND NUMBER 6: DEFLECTION 3129 (for M101A1, use DEFLECTION 2729; for M114A1, use DEFLECTION 2329).

Standards

The examinee--

- Sets the deflection on the reset counter or slipping azimuth scale.
- Centers the cross-level and pitch-level bubbles on the panoramic telescope mount.
- Traverses the howitzer until the vertical line of the panoramic telescope reticle is on the same straight vertical portion of the distant aiming point that the examinee referred to after command number 4.
- Checks the centering of the bubbles.
- Re-lays the howitzer if necessary.
- Announces READY when the action is completed.

Time in Seconds	Points
8.0 or less	4.0
8.1 to 9.0	3.0
9.1 to 10.0	2.0
10.1 or more	0.0

Task 10. Correcting for Displacement with Aiming Posts

Using aiming posts, lay a piece on an announced deflection and take up proper displacement.

Conditions

- A howitzer will be prepared for action.
- Aiming posts will be emplaced at the prescribed deflection, however, the far aiming post will be moved perpendicular to the line of sight through the panoramic telescope so that a 5- to 10-mil displacement with the near aiming post will occur.
- The howitzer will be oriented so that the motor carriage or the trails will not have to be shifted.
- The examiner will command **DEFLECTION 3160.** (For M101A1, use DEFLECTION 2760. For M114A1, use DEFLECTION 2360.)

Standards

The examinee--

- Sets the announced deflection on the panoramic telescope.
- Centers the cross-level and pitch-level bubbles on the panoramic telescope mount.
- Traverses the howitzer until the far aiming post appears midway between the near aiming post and the vertical crosshair of the telescope.
- Checks the centering of the bubbles.
- Re-lays the howitzer if necessary.
- Announces READY when action is completed.

Time in Seconds	Points
8.0 or less	4.0
8.1 to 9.0	3.0
9.1 to 10.0	2.0
10.1 or more	0.0

Task 11. Correcting for Displacement with the Collimator

Lay a piece on an announced deflection and take up proper displacement using the collimator.

Conditions

- A howitzer will be prepared for action.
- A collimator will be emplaced at the prescribed deflection; however, the collimator will be rotated slightly so that a 5- to 10-mil displacement will occur.
- The examiner will command **DEFLECTION 3345.** (For M101A1, use DEFLECTION 2945. For M 114A1, use DEFLECTION 2545.)

Standards

The examinee--

- Sets the announced deflection on the panoramic telescope.
- Centers the cross-level and pitch-level bubbles on the panoramic telescope mount.

- Traverses the howitzer until the vertical crosshair of the telescope is in its proper position to the 0 line of the collimator.

- Checks the centering of the bubbles.
- Re-lays the howitzer if necessary.
- Announces READY when action is completed.

Time in Seconds	Points
8.0 or less	4.0
8.1 to 9.0	3.0
9.1 to 10.0	2.0
10.1 or more	0.0

Task 12. Laying for Quadrant with the Elevation Scale

Using the elevation scale, lay a piece on an announced quadrant.

Conditions

- The howitzer will be prepared for action.
- The examinee will be posted as the assistant gunner (not applicable on the M114A1).
- The setting on the elevation scale will be within 40 mils of the announced quadrant.
- Examiner commands **QUADRANT 375.**

Standards

The examinee--

- Sets the announced quadrant on the elevation scale.
- Centers the cross-level and pitch-level bubbles.
- Elevates or depresses the tube as necessary.
- Announces READY when action is completed.

Time in Seconds	Points
6.0 or less	4.0
6.1 to 7.0	3.0
7.1 to 8.0	2.0
8.1 or more	0.0

Task 13. Laying for Quadrant with the Gunner's Quadrant

Using the gunner's quadrant to lay for quadrant, execute two commands given by the examiner.

Conditions

- The howitzer will be prepared for action.
- The examinee will be posted to the left of and facing the breech.
- Prior to each command the howitzer will be elevated to within 40 mils of the announced quadrant.

- Before each command the examinee will be provided with a gunner's quadrant set at 0.
- An assistant will elevate or depress the tube at the examinee's direction.

COMMAND NUMBER 1: QUADRANT 219.

Standards

The examinee--

- Sets the announced quadrant on the gunner's quadrant.
- Sets the gunner's quadrant on the breech ring or appropriate sight mount.
- Directs the assistant to elevate or depress the tube until the quadrant bubble is centered.
- Announces READY when the action is completed.

Time in Seconds	Points
6.0 or less	4.0
6.1 to 7.0	3.0
7.1 to 8.0	2.0
8.1 or more	0.0

COMMAND NUMBER 2: QUADRANT 1037.

Standards

Same as for command number 1.

Task 14. Breechblock Disassembly

Disassemble a breechblock and name the component parts.

Conditions

- A canvas will be placed by the breech of a howitzer for the display of the breechblock components.
- The examinee will be provided access to a complete set of section tools.
- An assistant will be provided to aid in lifting the breech.

Standards

- Using the proper tools, the examinee disassembles the breechblock.
- He identifies all parts to the examiner.

Time in Minutes	Points
12 or less	4.0
More than 12	0.0

Number of parts misidentified _____ $\times 0.5 =$ - _____.

Deduct 0.5 point for each part incorrectly identified; however, the points deducted must not exceed the points credited for this task.

Task 15. Breechblock Assembly

Assemble a completely disassembled breechblock.

Conditions

- A completely disassembled breechblock will be displayed on a canvas by a howitzer.
- A complete set of section tools will be provided.
- An assistant will be provided to aid in moving the breechblock.

Standards

- The examinee completely assembles the breechblock.

Time in Minutes	Points
8 or less	4.0
More than 8	0.0

Task 16. Howitzer Lubrication

Perform daily, monthly, and quarterly lubrication on the howitzer.

Conditions

- The examinee will be provided a complete set of lubrication equipment and lubricants authorized for use by battery personnel. The lubricants will be clearly marked.
- The lubrication order for the howitzer will be provided.

Standards

•Without actually lubricating the weapon, the examinee selects the proper lubricants and equipment and describes to the examiner how he would check and perform all the lubrications required on the lubrication order.

Time in Minutes	Points
5 or less	4.0
More than 5	0.0

Total number of errors or omissions _____ $\times 0.5 =$ - _____.

Deduct 0.5 point for each lubrication point missed and for each improperly selected lubricant or lubricating device. The total number of points deducted will not exceed the total number of points credited for this task.

APPENDIX D

TEST FOR QUALIFICATION OF HOWITZER SECTION CHIEFS

Purpose and Scope

This appendix is a qualification test for prospective howitzer section chiefs. The test is readily adaptable to all weapons systems. The test is a performance-oriented examination of a non-commissioned officer's ability to perform the duties and technical functions expected of a qualified 134B0 upon his arrival in a unit. The battery commander may use the results of the examination to--

- Evaluate the knowledge of artillery and the technical expertise of a prospective howitzer section chief prior to his assignment to a section.
- Determine the subject areas that require refresher or remedial training.

The test may also be administered at battalion level by the operations section. Before an NCO is assigned to a firing battery, his qualifications for that critical duty position can be determined and, if necessary, a remedial training program can be developed and administered. Upon successful completion of the additional training, and with a satisfactory rating on a subsequent qualification test, the NCO would then be properly prepared to take over responsibility for a section. This would free the firing battery from the additional administrative burden of evaluating and training a prospective section chief.

The test is designed to be administered during one 4-hour period. It consists of two phases, a PERFORMANCE TEST phase requiring 3 hours and a FIELD ARTILLERY KNOWLEDGE TEST phase requiring 1 hour.

- The performance test phase will require the examinee to demonstrate proficiency in tasks that are rated as critical to his duty position. The tests for this phase are divided into three groups. All tasks in group I (1 hour) should be administered. Tasks totaling 1.5 hours should be selected from group II, and tasks totaling 0.5 hour should be selected from group III. The examinee should not be told until immediately prior to the start of the examination which tasks he will be required to perform.

- The artillery knowledge test phase consists of discussion and fill-in-the-blank types of questions, of which 15 should be selected. One hour should be allotted for this written or oral test.

Format of the Performance Tests

The task is a general statement of the requirement for the particular test.

The conditions outline the specific environment or situation in which the test will be administered. They state what assistance or reference materials, if any, are authorized and what equipment or personnel are required for proper test administration.

The standards are the requirements for successful completion of that particular task. Specific technical procedures as required by the task will be referenced and evaluated by the examiner from the established procedures in the appropriate reference.

Preparation

All necessary preparations, as indicated in the CONDITIONS for each task, will be made prior to the beginning of that task. The examiner will insure that the examinee understands the task to be performed.

Scoring

The performance tests will be administered on a GO/NO-GO basis; the examinee either passes or fails. The examiner will base his judgments upon the criteria stated in the standards and upon the most current reference for that particular task. The field artillery knowledge test will be graded similarly. If the test is administered orally, the examiner will make appropriate remarks on his score sheet concerning those questions that were not correctly or completely answered. There is no passing or failing score. The battery commander will review the results of the test and the test administrator's written comments and judge whether or not the NCO is sufficiently proficient to perform the duties expected of him.

Qualification

According to the commander's judgment, additional training may be necessary. The NCO should be allotted a reasonable period of time to raise his level of technical proficiency to the standards of the unit and to prepare for a second qualification test. At the completion of the prescribed training period, the examination should again be administered and a mix of tasks from groups II and III different from the original mix should be selected. If the NCO achieves a satisfactory evaluation on the second qualification test, he should then be judged as technically proficient and prepared to assume responsibilities for a howitzer section.

PHASE I — PERFORMANCE TESTS

GROUP I

- Perform all tasks (1 through 11).
- Time allotted for group I--60 minutes.

Task No.	Title	Execution Time
1	Boresighting (two methods) (10-min setup)	15 min
2	Lay Cannon for Direction	3 min
3	Emplace Aiming Points	5 min
4	Measure Site to Crest	3 min
5	Refer the Piece	3 min
6	Set and Lay for Deflection	5 min
7	Set and Lay for Quadrant	3 min
8	Lay for Quadrant with a Gunner's Quadrant	3 min
9	Measure the Quadrant	3 min
10	Measure the Deflection	3 min
11	Correct for Displacement	3 min

GROUP II

- Perform tasks selected by examiner.
- Time allotted for group II--90 minutes.

Task No.	Title	Execution Time
12	Conduct Fire Control Alinement Tests (1 hour set up)	30 min

13	Disassemble and Assemble the Breech Mechanism	30 min
14	Test of Gunner's Quadrant	5 min
15	Level the Trunnions	30 min
16	Comparison Test of the M140 Alinement Device	15 min
17	Emplace Azimuth Markers	5 min
18	Prepare the Panoramic Telescope and Elbow Telescope (if applicable) for use in Direct Laying	3 min
19	Engage a Target by Direct Fire Techniques	5 min
20	Establish Recuperator Oil Reserve (M110/M107)	5 min
21	Check and Adjust Loader-Rammer Timing (M110/M107)	5 min
22	Perform the Zero Pressure Check (M109/M109A1)	5 min

GROUP III

- Perform tasks selected by examiner.
- Time allotted for group III-30 minutes.

Task No.	Title	Execution Time
23	Check Lubrication Levels on the M548 Cargo Carrier	15 min
24	Record Rounds Fired on the Weapon Record Data Card (DA Form 2408-4)	10 min
25	Perform ESC on Section Vehicle or Prime Mover	30 min
26	Check and Adjust the Headspace and Timing on the .50 Caliber Machine Gun	10 min
27	Prepare Range Cards	10 min
28	Using an Aiming Circle, Lay for Direction Using the Grid Azimuth Method	10 min
29	Measure an Azimuth and Compute a Back Azimuth with an M-2 Compass	5 min
30	Record Entries for a Day's Operation on DA Form 2408-1 (daily)	5 min
31	Determine the Proper Lubricant to use in the Transmission When the Expected Temperature is above +32° F.	5 min

GROUP I

Task 1. Boresighting by The Testing Target, Distant Aiming Point, Collimator, Standard Angle, and M140 Alinement Device Methods.

Conditions

- The test site will provide at least one suitable distant aiming point.

- All equipment and material required for each method of boresighting will be available.
- The panoramic telescope and direct fire telescope (if applicable) will be installed and adjusted out of boresight prior to each test.
- The collimator will be set up and operated by a qualified assistant.
- The examinee will perform the duties of gunner, assistant gunner, and section chief.
- Two of the five methods of boresighting will be selected by the examiner for the test.

Standards

The howitzer is accurately and correctly boresighted within 7 minutes for each of the two selected methods.

- Testing target method.
- Distant aiming point method.
- Standard angle method.
- Collimator method.
- M140 alinement device method.

GO	NO GO	INIT

Examiner's Comments:

Task 2. Lay Cannon for Direction.

Conditions

- The tube will be moved 40 to 50 mils out of lay prior to the beginning of the test.
- Wire communications will be provided between the aiming circle and the cannon.
- The examinee will position himself as the gunner.

Standards

The cannon is properly laid with a difference of 0 mils in three sightings or less.

Examiner's Comments:

GO	NO GO	INIT

Task 3. Emplace Aiming Points (Aiming Posts, Collimator) and Select a Distant Aiming Point.

Conditions

- The examinee will be provided an assistant to emplace the collimator and aiming stakes in accordance with the examinee's instructions.
- The examinee will perform the duties of the gunner.

Standards

- The collimator is correctly and accurately emplaced.
- The aiming posts are correctly and accurately emplaced.
- A proper distant aiming point is chosen and correctly used.
- Standard hand and arm signals are used by the examinee in his instructions to his assistant.

GO	NO GO	INIT

Examiner's Comments:

Task 4. Measure Site to Crest.**Conditions**

- The howitzer will be prepared for action with a readily identifiable crest located to its front.
- Assistants will be provided to elevate or traverse the tube as directed by the examinee.

Standards

The examinee accurately and correctly measures and reports site to crest.

GO	NO GO	INIT

Examiner's Comments:

Task 5. Refer the Piece.**Conditions**

- The howitzer will be laid and prepared for action.
- The examinee will perform the duties of the gunner.
- The aiming circle will be manned by a qualified operator.

Standards

Upon command from the aiming circle operator NUMBER () AIMING POINT THIS INSTRUMENT, REFER, the examinee properly refers and reports the deflection.

GO	NO GO	INIT

Examiner's Comments:

Task 6. Set and Lay for Deflection.**Conditions**

- The piece will be prepared for firing with either the collimator or the aiming posts as the

primary aiming point.

- The examinee will perform the duties of the gunner.

•Three tests will be administered with the size of the deflection shift being different for each test.

Standards

•For a deflection shift between 140 and 180 mils, the examinee properly and accurately lays the piece within 25 seconds.

•For a deflection shift between 60 and 100 mils, the examinee properly and accurately lays the piece within 20 seconds.

•For a deflection shift between 10 and 20 mils, the examinee properly and accurately lays the piece within 10 seconds.

GO	NO GO	INIT

Examiner's Comments:

Task 7. Set and Lay for Quadrant.

Conditions

- The piece will be prepared for firing.

- The examinee will perform the duties of the assistant gunner.

•Three tests will be administered with each test requiring a quadrant change from 20 to 40 mils.

Standards

For each quadrant change, the examinee properly and accurately lays the piece within 10 seconds.

Test 1, quadrant _____ .

Test 2, quadrant _____ .

Test 3, quadrant _____ .

GO	NO GO	INIT

Examiner's Comments:

Task 8. Lay for Quadrant with Gunner's Quadrant.

Conditions

- The piece will be prepared for firing.

- An assistant gunner will be provided to perform duties as directed by the examinee.

•Three tests will be administered with the size of the quadrant change being from 30 to 60 mils for each test.

- The gunner's quadrant will be set at 0 for the first test.

Standards

For each quadrant change, the examinee properly and accurately lays the piece for quadrant within 30 seconds.

Test 1, quadrant _____ .

Test 2, quadrant _____ .

Test 3, quadrant _____ .

GO	NO GO	INIT

Examiner's Comments:

Task 9. Measure the Quadrant.**Conditions**

- The piece will be laid at a predetermined quadrant.
- The gunner's quadrant will be set at 0.
- The examinee will be required to measure the quadrant and will be assisted by a qualified assistant gunner.

Standards

The examinee properly and accurately measures and reports the quadrant within 30 seconds.

GO	NO GO	INIT

Examiner's Comments:

Task 10. Measure the Deflection.**Conditions**

- The piece will be laid on the primary aiming point (aiming posts or collimator).
- An aiming point within 200 mils left or right of the primary aiming point will be designated and identified by the examinee.

Standards

The examinee properly and accurately measures and reports the deflection to the designated aiming point within 15 seconds.

GO	NO GO	INIT

Examiner's Comments:

Task 11. Correct for Displacement of Aiming Posts and Collimator.

Conditions

- The examinee will be provided a howitzer that is laid for direction.
- Two tests will be conducted that will require the examinee to correct for displacement of the weapon during firing.
- Aiming stakes and a collimator will be emplaced to simulate a minimum of 20 mils of displacement caused by firing.

Standards

- The correct sight picture is established by use of aiming posts.
- The correct sight picture is established by use of the collimator.

GO	NO GO	INIT

Examiner's Comments:

GROUP II

Task 12. Conduct Fire Control Alinement Tests

Conditions

- The trunnions will be leveled prior to the beginning of the test.
- A reference point more than 50 meters away from the howitzer will be available.
- A serviceable gunner's quadrant will be provided.
- The howitzer will be boresighted prior to the beginning of the tests.
- While conducting the tests, the examinee may use the operator's manual as a reference.
- If time is a critical factor, conditions 1 and 4 may be simulated.

Standards (M102, M109/109A1, M110/110E2, M107 Howitzers)

•The reliability of deflections test is properly and accurately performed.

•The reliability of special corrections test is properly and accurately performed.

•The inspection of the telescope mount (azimuth walkoff check) is properly and accurately performed.

•The test of the M14 or M15 elevation quadrant and the auxiliary quadrant is properly and accurately performed.

Standards (M101A1 and M114A1 Howitzers)

•The actuating arm pivot test is properly and accurately performed (M114A1 only).

•The elevation scale test (M114A1) or test of the range quadrant

GO	NO GO	INIT

(M101A1) is properly and accurately performed.

- The elevation micrometer test (M114A1) or test of the azimuth compensating mechanism on the panoramic telescope mount (M101A1) is properly and accurately performed.

- The telescope mount check (M114A1) is properly and accurately performed.

- The telescope mount cross-level check (M114A1) is properly and accurately performed.

- The telescope mount elevation level test (M114A1) is properly and accurately performed.

- The telescope socket alinement test (M114A1) is properly and accurately performed.

GO	NO GO	INIT

Examiner's Comments:

Task 13. Disassemble and Assemble the Breech Mechanism.

Conditions

The examinee will be provided--

- All necessary tools and equipment.
- One qualified assistant to perform duties as directed by the examinee.

Standards

- Breech mechanism is properly disassembled within 8 minutes, to include--

- Disassembly of the firing mechanism.
- Removal of the breechblock from the carrier.

- Breech mechanism is properly assembled within 12 minutes and the breech opens and closes properly after assembly.

GO	NO GO	INIT

Examiner's Comments:

Task 14. Test of Gunner's Quadrant.

Conditions

- A serviceable gunner's quadrant and all necessary tools and equipment will be provided.
- An assistant gunner will be provided to perform actions as directed by the examinee.
- The examinee will perform the duties of the gunner.

Standards

•The end-for-end test is properly and accurately performed within 2 minutes.

•The micrometer test is properly and accurately performed within 1 minute.

GO	NO GO	INIT

Examiner's Comments:

Task 15. Level the Trunnions by the Plumblin or the Scribed Line Method.**Conditions**

•All necessary tools, equipment, and personnel will be provided the examinee.

•If the plumblin method is used, the test will be conducted on a level surface, preferably a hardstand, and in an area sheltered from the wind.

•The examinee may use reference material during the test.

Standards

The examinee is proficient in the procedures for leveling the trunnions by either the plumblin method or the scribed line method.

GO	NO GO	INIT

Examiner's Comments:

Task 16. Comparison Test of the M140 Alinement Device. (Not applicable to M101A1 and M114A1.)**Conditions**

•All necessary tools and equipment, to include three M140 alinement devices, will be provided to the examinee.

•The examinee will perform the duties of the gunner and will be provided a qualified assistant to perform actions as directed.

•No reference materials will be used by the examinee during the conduct of this test.

Standards

The test is accurately and correctly performed according to the procedures outlined in the appropriate TM or user's manual.

GO	NO GO	INIT

Examiner's Comments:

Task 17. Emplace the Azimuth Markers.**Conditions**

•The howitzer will be emplaced in a simulated firing position and will be prepared for indirect laying.

•The examinee will be provided--

- a. One roll of narrow masking tape or four markers.
- b. One felt-tipped marker (M109/M109A1 only).
- c. An assistant to perform duties as directed.
- d. A suitable distant aiming point.
- e. The azimuth of fire.

Standards

Azimuth markers are properly emplaced within 5 minutes.

Examiner's Comments:

GO	NO GO	INIT

Task 18. Prepare the Panoramic Telescope and Elbow Telescope (If Applicable) For use in Direct Laying.**Conditions**

•The piece will be emplaced for direct fire with the panoramic telescope and, if applicable, the elbow telescope mounted in position.

•Telescope(s) will have been boresighted.

•An initial fire command will be issued requiring the examinee to prepare for a direct fire mission.

•The examinee will perform the duties of the gunner and the assistant gunner. (Gunner only on the M114A1.)

Standards

•The panoramic telescope is prepared for action within 30 seconds.

•The elbow telescope is prepared for action within 15 seconds.
(Not applicable on the M114A1.)

Examiner's Comments:

GO	NO GO	INIT

Task 19. Lay the Piece for Direction and Range and Engage a Target by Using Direct Fire Techniques.

Conditions

- A piece will be emplaced for direct fire and the telescope(s) will be prepared for use.
- A simulated fire mission will be issued requiring the examinee to engage a moving target at a range of at least 1,000 meters.
- The examinee will perform the duties of gunner and assistant gunner. (Gunner only on the M114A1.)
- Three tests will be administered in each duty position that will require the examinee to--
 - a. Lay for initial range and two subsequent range changes as assistant gunner (gunner on the M114A1).
 - b. Lay for initial direction and lead and two subsequent lead changes as a gunner.

Standards

- Examinee performs all the duties of the assistant gunner (lays for range on the M114A1) in a direct fire mission in a satisfactory manner.
- Examinee performs all the duties of the gunner in a direct fire mission (lays for direction on the M114A1) in a satisfactory manner.

GO	NO GO	INIT

Examiner's Comments:

Task 20. Establish Recuperator Oil Reserve (M110/M107 Only).

Conditions

- The examinee will be provided one M110/M107 howitzer configured in the traveling position.
- One assistant will be provided to perform duties as requested by the examinee.

Standards

- All preliminary steps are performed in accordance with TM 9-2300-216-10.
- Proper procedures are followed if the index pin fails to move.
- If the index pin moves, the examinee explains the proper procedure to follow if it had not moved.

GO	NO GO	INIT

Examiner's Comments:

Task 21. Check and Adjust Loader-Rammer Timing (M110/M107 ONLY).**Conditions**

- An M110/M107 howitzer will be provided. The howitzer spade will be lowered to the ground.
- An assistant will be provided to start the howitzer at the direction of the examinee.
- The loader-rammer will be adjusted out of time by the examiner.

Standards

•Examinee, using proper procedures, inspects loader-rammer for proper timing.

•Examinee properly adjusts loader-rammer timing.

GO	NO GO	INIT

Examiner's Comments:

Task 22. Perform the Zero-Pressure Check (M109/M109A1 ONLY).**Conditions**

An M109/M109A1 howitzer and all necessary tools and equipment will be provided.

Standards

- All preliminary preparatory steps are accomplished properly.
- Examinee correctly reads nitrogen pressure on the pressure gage and explains the procedures to follow if the pressure is below 450 psi.
- Examinee correctly reads the sight gage on the main hydraulic reservoir and explains how to replenish the oil if it is low.

GO	NO GO	INIT

Examiner's Comments:

GROUP III**Task 23. Check Lubrication Levels on the M548 Cargo Carrier. (M109/M109A1, M110/M110E2 AND M107 Units ONLY.)****Conditions**

An M548 cargo carrier and operator's TM are provided.

Standards

- The engine oil is properly and accurately checked.
- The transmission oil is properly and accurately checked.
- The differential oil level is properly and accurately checked.
- The final drive oil levels are properly and accurately checked.

GO	NO GO	INIT

Examiner's Comments:

Task 24. Record the Rounds Fired on the Weapon Record Data Card (DA Form 2408-4).

Conditions

- The examinee will be provided--
 - a. DA Form 2408-4 with columns 1 through 4 completed; several lines pertaining to columns a through i will also contain correct entries. The most recent entry in column g will indicate that about 30 percent of the tube's estimated life remains.
 - b. Fire commands requiring the use of a minimum of two different propellant charges, each with a different wear factor for computing EFC, will be given.
- The examinee will be required to compute the estimated remaining life of the tube as a result of each fire mission and to make appropriate entries on DA Form 2408-4.

Standards

DA Form 2408-4 is correctly and completely filled out on the basis of data from simulated fire missions.

GO	NO GO	INIT

Examiner's Comments:

Task 25. Perform an Equipment Serviceability Inspection (ESC) on the M548 Cargo Carrier or the Appropriate Weapon Prime Mover.

Conditions

- The vehicle will be emplaced on a level surface.
- The examinee will be provided--
 - a. The appropriate ESC technical manual and vehicle logbook.
 - b. DA Form 2404.
 - c. Necessary tools and equipment to perform the inspection.

Standards

- The ESC rating is correct.
- The inspection is correctly and accurately performed.

GO	NO GO	INIT

Examiner's Comments:

Task 26. Check and Adjust the Headspace and Timing on the .50 Caliber Machinegun (Not Applicable in Towed Units).**Conditions**

- The machinegun will be adjusted out of correct headspace and timing prior to the start of the test.
- The examinee will be provided an assistant to perform duties as directed.
- All necessary tools and equipment will be available.
- No reference materials will be used by the examinee during the test.

Standards

- The headspace is properly checked and adjusted within 3 minutes of the start time.
- The timing is properly checked and adjusted within 6 minutes of the start time.

GO	NO GO	INIT

Examiner's Comments:

Task 27. Prepare Range Cards**Conditions**

- The test will be administered from a simulated howitzer firing position that offers a view of varied terrain and reference points.
- The examinee will be assigned simulated sectors of responsibility and will be required to prepare accurate and complete range cards for both the howitzer and a machinegun.

Standards

- An accurate and complete range card is prepared for the howitzer within 10 minutes of the start time for the task.
- An accurate and complete range card is prepared for the machinegun within 10 minutes of the start time for the task.

GO	NO GO	INIT

Examiner's Comments:

Task 28. Using an Aiming Circle, Lay the Piece for Direction by the Grid Azimuth Method.

Conditions

- The examinee will be provided--
 - a. A declinated M2 aiming circle.
 - b. An emplaced piece prepared for laying.
 - c. The azimuth of fire.
- The examinee will perform the duties of the chief of firing battery and will be assisted by a qualified gunner.

Standards

- The aiming circle is properly set up.
- The 0-3200 line of the aiming circle is properly oriented in the direction of fire.
- The proper commands and procedures are used in laying the piece to an accuracy of 0 mils.

GO	NO GO	INIT

Examiner's Comments:

Task 29. Measure the Azimuth and Compute a Back-Azimuth.

Conditions

- Sets of aiming posts will be alined to mark two different directions.
- The examinee will be provided a declinated M2 compass and will--
 - a. Measure and report the direction as described by the first set of alined aiming posts.
 - b. Measure the direction as described by the second set of alined aiming posts and compute the *back-azimuth*.

Standards

- The direction is correctly reported to an accuracy of ± 10 mils within 30 seconds of the start time for the task.
- The back-azimuth is correctly reported to an accuracy of ± 10 mils within 40 seconds of the start time for the task.

GO	NO GO	INIT

Examiner's Comments:

Task 30. Record Entries for a Day's Operation on DA Form 2408-1.**Conditions**

- The examinee will be provided--

a. DA Form 2408-1, daily, with the heading, the initial entry, and columns *a* and *f* completed.

b. He will be given the speedometer and tachometer readings and the total gallons of fuel and the total quarts of oil added.

- The examinee will be required to record the proper entries in columns *b*, *c*, *d*, *e*, and *g* on the DA Form 2408-1, daily.

Standards

DA Form 2408-1 is correctly and completely filled out on the basis of the data given.

GO	NO GO	INIT

Examiner's Comments:

Task 31. Determine the Proper Lubricant to use in the Transmission When the Expected Temperature is Above +32° F.**Conditions**

- The examinee will be provided the vehicle lubrication order.

- The examinee will be required to determine the proper lubricant to use in the transmission when the expected temperature is above +32° F.

Standards

Demonstrates proper use of the lubrication order and is able to determine the proper lubricant.

GO	NO GO	INIT

Examiner's Comments:

PHASE II — FIELD ARTILLERY KNOWLEDGE TEST

1. During a field exercise, you have encountered difficulty with your self-propelled howitzer (prime mover) and it must be towed back to your motor pool, a distance of 6 miles.

a. What must be done to prepare it for towing?

b. What equipment will be needed to properly tow it?

2. What publications do you as section chief need to properly maintain your section equipment?

3. Your weapon has a cold tube and you are attempting to fire your first round of the day using charge 4. Your number 1 cannoneer attempted to fire the weapon; however, the cannon did not fire. What procedures will you follow in dealing with this misfire?

4. Why is a projectile painted?

a.

b.

5. What is the standard weight zone (square) for the HE projectile for your weapon system?

6. Why is it important to fire the *announced* lot number of projectile and, if applicable, propelling charge?

7. List and discuss the use of the two fuze wrenches that are authorized for tightening fuzes onto a projectile.

a.

b.

8. List and discuss the use of three authorized fuze setters. In your discussion explain--

a. The physical design of the fuze setters.

b. The types of fuzes, by model, for which each was designed.

9. When would you use the following fuzes in engaging a direct fire target?

a. Fuze quick.

b. Fuze delay.

c. Fuze time.

d. Fuze concrete piercing.

10. Discuss the proper methods for engaging a direct fire target located within the following ranges.

a. 0-400 meters.

b. 400-1,500 meters.

c. 1,500-2,500 meters.

d. Over 2,500 meters.

11. List and discuss the two methods a gunner may use to set off the correct lead when engaging a moving direct fire target.

12. Name five unsafe acts that could result in an accident or injury to personnel and damage to equipment during firing.

1.

2.

3.

4.

5.

13. List three precautions that should be taken in loading or unloading a hot tube.

1.

2.

3.

14. For uniformity and accuracy in using the sights and the elevating and traversing mechanisms, you train your crew to--

- a. Set numbers from ____ to ____ numbers.
- b. Elevate the tube in the direction of ____.
- c. Traverse in final motion from ____ to ____.

15. You are checking your weapon for proper equilibration. What procedures would you follow in making the check?

What would you do if the tube were more difficult to elevate?

What would you do if the tube were more difficult to depress?

16. On your weapon, the maximum rate of fire is ____ and the sustained rate of fire is ____.

17. The tube on your weapon has an EFC life of ____ rounds.

18. Fire control alinement tests should be conducted--

- a.
- b.
- c.
- d.

19. The command that is the authority for a chief of section to fire his weapon when loaded and ready, unless the method of fire includes a restrictive command, is _____

The command given in an emergency to cause the guns to immediately stop firing is _____

The command you would give to FDC to request the repetition of the deflection is (you are on number 2 piece) _____

20. The following is a list of possible initial fire command elements.

- a. BATTERY ADJUST.
- b. BATTERY 3 ROUNDS, VT IN EFFECT.
- c. FIRE MISSION.
- d. QUADRANT 444.
- e. SHELL HE.

f. DEFLECTION 1234.

g. LOT XY.

h. FUZE QUICK.

i. CHARGE 5.

Of the above listed elements, assuming the adjusting piece, lot, shell, and fuze have been designated as standard, the elements (in proper sequence) that will be sent to the guns for an adjust firing mission are--

a. *a, i, e, f, d, b.*

b. *c, g, i, h, f, d.*

c. *a, g, i, f, b, d.*

d. *c, a, i, f, d, b.*

21. You have a round in the tube and the XO has commanded you to unload it. What procedure will you follow to remove the round from the tube and what will you do with the projectile after it has been unloaded?

a.

b.

c.

d.

e.

f.

g.

22. To be acceptable for use as an aiming point or for boresighting, a distant aiming point must be at least _____ meters from the weapon.

23. You have received the following fire command:

FIRE MISSION, BATTERY 1 ROUND, ZONE 5 MILS, 5 QUADRANTS, CHARGE 4, DEFLECTION 2874, QUADRANT 304.

The quadrants you will fire are _____, _____, _____, _____ and _____.

24. You have received the following fire command:

FIRE MISSION, BATTERY 1 ROUND, SWEEP 10 MILS, 3 DEFLECTIONS, CHARGE 5, DEFLECTION 2741, QUADRANT 369.

The deflections which you will fire are_____,_____, and_____.

25. When may the command CHECK FIRING be given and by whom?

APPENDIX E

TEST FOR THE QUALIFICATION OF SAFETY PERSONNEL

Purpose and Scope

This appendix is a series of tests designed to be used by the commander as a guide in developing a program that fully qualifies all personnel involved in firing. The commander may use these tests, modified as required to meet local requirements, to--

- Determine the level of knowledge of selected personnel concerning safety regulations and procedures.
- Determine the specific areas that require refresher or remedial training.

Format

The tests are divided into two sections. Section I is designed for those personnel not ordinarily tasked to compute safety data (i.e., the howitzer/gun section chief and the chief of firing battery and the gunnery sergeant). Section II is designed for all officers and any other personnel who may be responsible for the computation of safety data. At the discretion of the examiner, section I may also be given. Section III provides a grading key.

Test Administration

Examinees should be allowed approximately 1 week to prepare for the examination. During this period they should have ready access to the following references:

- AR 385-63.
- FM 6-40.
- FM 6-50.
- Local range regulations, SOP's, etc. pertaining to safety.
- Weapon user's manual or field manual.

The following should be provided by the examiner for use by the examinee for test 4, Section II, ONLY.

- Applicable tabular and graphical firing tables.
- Graphical site table.
- FM 6-50.
- AR 385-63.
- One copy of local range regulations.

SECTION I

TEST 1, TRUE AND FALSE

1. _____ Each section chief must be informed of the minimum and maximum quadrants and the left and right deflection limits.
2. _____ It is safe to fire a projectile without a fuze.

3. _____ In direct fire, the chief of section must insure that minimum elevation limits are not violated.
4. _____ During heavy rain, the M514 fuze should not be fired.
5. _____ The chief of section will verify the serviceability of ammunition.
6. _____ Chemical and high-explosive projectiles can be stored together.
7. _____ Projectiles (and fuzes) that have been removed from a cannon by means of ramming should be fired on the next mission.
8. _____ Time fuzes previously set but not fired must be reset to safe.
9. _____ If the left deflection limit is 3650 mils, it is safe to fire a round at deflection 3700.
10. _____ The maximum and minimum quadrants do not change even if the charge or type of ammunition changes.
11. _____ When the firing point changes, so does the safety diagram.
12. _____ Once a howitzer is initially laid for direction with the aiming circle, it should never be traversed prior to emplacement of the collimator and aiming posts.
13. _____ A registration will cause the deflection limits, minimum time, and maximum and minimum quadrants of the safety diagram to change.
14. _____ Before firing a round, the chief of section must insure that the correct number and type of remaining charge increments are held up at the rear of the piece.
15. _____ The chief of section has final responsibility for the safety of the crew and the settings on his weapon prior to the command FIRE.

TEST 2, MULTIPLE CHOICE

16. Who is responsible for insuring that the proper time is set on a fuze before a round is loaded into a howitzer?
 - a. Chief of firing battery.
 - b. Executive officer.
 - c. Number 1 cannoneer.
 - d. Safety officer.
17. Who are the individuals specifically responsible for safety in service practice?
 - a. Range officer, OIC, safety officer, chief of section, and FDC.
 - b. Executive officer, safety officer, and battery commander.
 - c. Executive officer, safety officer, unit commander, and chief of section.
 - d. Executive officer, chief of firing battery, and safety officer.
18. What is the proper fuze setting to cause the M564 MTSQ fuze to function on impact?
 - a. 90.0 seconds.
 - b. Safe.
 - c. 100.0.
 - d. PD.

19. When the end-for-end test of the gunner's quadrant (M1 or M1A1) is performed, the maximum allowable error is plus or minus--
- 4 mils.
 - 0.4 mil.
 - 1 mil.
 - 0.1 mil.
20. The proper command for verifying the lay of number 1 howitzer is--
- NUMBER 1, AIMING POINT THIS INSTRUMENT, REFER.
 - NUMBER 1, REFERRED DEFLECTION THIS INSTRUMENT.
 - NUMBER 1, ADJUST.
 - NUMBER 1, ADJUST, AIMING POINT THIS INSTRUMENT.
21. Ammunition will NOT be fired if--
- it is over 6 months old.
 - the powder temperature is not known.
 - the lot number is not known.
 - it is more than 1 year old.
22. Which of the following best describes the use of a safety diagram?
- To check the fire commands against right and left deflection limits only.
 - To compare the announced fire commands against the safety limit data.
 - To graphically check the impact area against the range limits.
 - To compare the announced fire commands with the minimum range limits.
23. Which of the following constitutes an unsafe act?
- Failure to swab the powder chamber after each round.
 - Failure of the chief of section to check the gunner's sight picture prior to firing each round.
 - Failure of the chief of section to announce ON THE WAY.
 - Failure of the gunner to announce READY.
24. Who is authorized to announce CHECK FIRING?
- Executive officer only.
 - Safety officer only.
 - Chief of section or gunnery sergeant only.
 - Anyone noticing an unsafe condition.

25. How long may a round remain chambered in a hot tube before it should be fired or removed from the weapon?

- a. 1 minute.
- b. 2 minutes.
- c. 5 minutes.
- d. 10 minutes.

TEST 3, COMPLETION

26. How are white phosphorus projectiles stored? Explain why.

27. If a VT fuze does not seat properly in the fuze well, what actions should be taken?

28. Describe the method for placing out safety stakes.

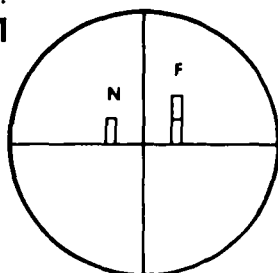
29. Which of the following sight diagrams illustrate correct sight pictures? Indicate your answer by placing an X in the appropriate spaces provided below.

a. (1) _____ (2) _____ (3) _____

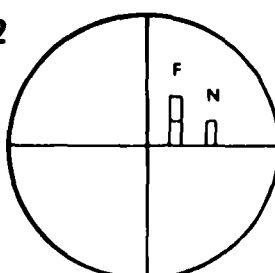
b. (1) _____ (2) _____ (3) _____ (4) _____

a.

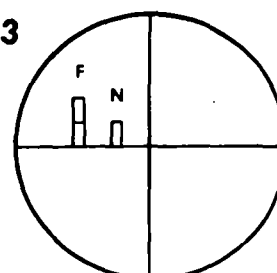
1



2

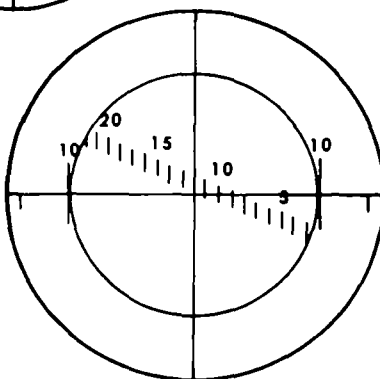


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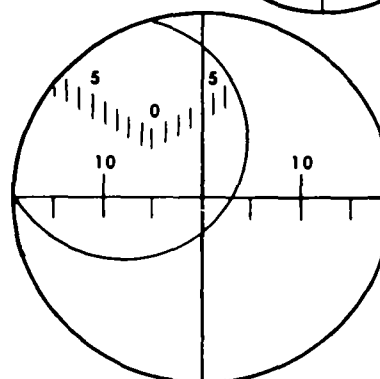


b.

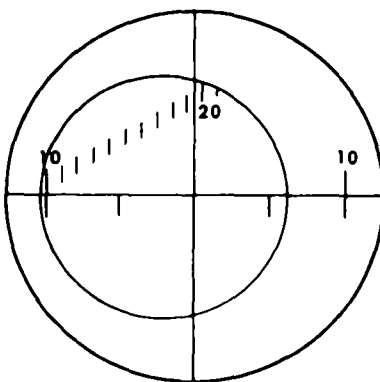
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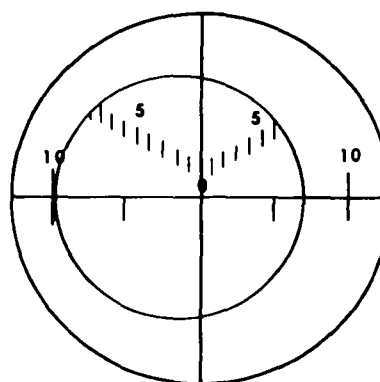
2



3



4



30. List the actions taken in the event of a misfire on an M109/M109A1 howitzer (cold tube, charges 2 through 8).

Note. Requirements 31 through 33 are based on the safety T diagram shown below, which was computed for charge 4.

417		
3685	3315	2900
209	177	
12.6	10.7	
19.0	17.0	

State whether the following data are safe or unsafe to fire; if unsafe, state why.

31. Lot XY, chg 4, fz quick, df 3695, QE 347.

32. Lot XY, chg 4, fz Ti, 12.2, df 3472, QE 253.

33. Lot XY, chg 4, fz VT, 17.0, df 3515, QE 312.

34. List the action taken in the event of a misfire on an M109A1 howitzer (hot tube), charge 3.

35. Describe the method for measuring the greatest angle of site to a crest in front of the weapon and list the five methods of determining piece-to-crest range. _____

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

SECTION II

TEST 1, TRUE AND FALSE

1. _____The safety officer must compare the safety card minimum QE with the XO's minimum QE and use the larger as the minimum QE.
2. _____In indirect fire, the safety officer must insure that the visible portion of the impact area is clear of personnel.
3. _____The OIC may authorize the firing of all types of ammunition from a firing point, if he insures that the proper charge is being fired.
4. _____Before illumination rounds are fired, the safety officer must insure that the firing of those rounds is authorized on his safety card.
5. _____The safety officer must insure that range clearance has been obtained before the battery may fire.
6. _____CHECK FIRING will be commanded *only* by the safety officer.
7. _____Firing will be halted when the range control commands CHECK FIRING.
8. _____The safety officer will verify the boresight of each piece prior to firing in each position.
9. _____Excess powder should be piled as high as possible for burning to prevent spreading of the flames and to reduce the chance of starting a range fire.
10. _____Because of the great range of the M107 SP gun, drift must be considered in the computation of safety limits prior to the registration.

TEST 2, MULTIPLE CHOICE

11. Verifying the boresight of each weapon is the specific responsibility of the--
 - a. section chief and safety officer.
 - b. safety officer and OIC of firing.
 - c. executive officer and range officer.
 - d. OIC of firing and FDO.

12. The safety officer has computed a minimum QE of 186 mils and the XO has determined a minimum QE of 195 mils for shell HE and fuzes quick and time. Which QE should be used as the safe minimum QE?
 - a. 186.
 - b. 195.
 - c. Either 186 or 195.
 - d. 190.

13. When the safety diagram is being constructed for high-angle fire prior to a registration, how are the deflection limits altered?
 - a. *Left* limit is moved left by minimum drift.
Right limit is moved left by maximum drift.
 - b. *Left* limit is moved left by maximum drift.
Right limit is moved left by minimum drift.
 - c. *Left* limit is moved right by minimum drift.
Right limit is moved right by maximum drift.
 - d. The deflection limits are not altered.

14. In order to inscribe a GFT setting on a GFT after a registration has been completed, the manufacturer's hairline is placed over the--
 - a. adjusted time.
 - b. adjusted elevation.
 - c. chart range.
 - d. adjusted quadrant.

15. When burning powder, unused flash reducers and igniters should be placed--
 - a. on the DOWNWIND end of the row of charge increments.
 - b. in the igniter train of powder.
 - c. on the UPWIND end of the row of charge increments.
 - d. in a row over the top of the charge increments.

TEST 3, COMPLETION

16. Prior to departing for the field, all officers in the chain of command responsible for safety should read and understand five references. They are--

a. _____

b. _____

c. _____

d. _____

e. _____

17. Equipment and material required by the safety officer in the field include--

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

18. Upon arrival at the prescribed firing point, the safety officer must check and verify the following:

a. _____

b. _____

c. _____

d. _____

19. To properly orient his aiming circle when the battery is laid by the grid azimuth method, the safety officer must insure that his aiming circle is no closer than _____ meters to artillery weapons.

20. The battery has been laid on an azimuth of 430 mils. You are prepared to check the lay. The declination constant of your aiming circle is 130 mils. What instrument reading would you place on the scales by use of the upper motion when you are preparing to orient your aiming circle on the azimuth of fire? _____

21. If a VT fuze does not seat properly in the fuze well, what actions should be taken? _____

22. Describe the procedures for burning unused powder increments.

23. At a firing point, how do you verify the declination constant on the aiming circle? _____

24. How does the safety officer verify the initial lay of the battery at a firing point? _____

25. Describe the procedures used by the safety officer in the testing target method to verify that the panoramic telescope and the direct fire telescope of each howitzer are alined with the bore of the howitzer. _____

TEST 4, PERFORMANCE

26. *Situation:* You are the executive officer of a 155-mm M109A1 SP howitzer battery firing shell HE, charge 5 green bag, fuzes M557, M564, and M514. The piece-to-crest range is 700 meters. The reported angles of site are as follows:

Number 1: +14 mils

Number 4: +14 mils

Number 2: +15 mils

Number 5: +13 mils

Number 3: +18 mils

Number 6: +12 mils

Required:

a. What is the XO's minimum QE for firing fuzes quick and mechanical time? _____

b. What is the minimum safe time for fuze VT M514? _____

c. What is the XO's minimum QE for firing fuze VT with a fuze setting less than the minimum safe time? _____

Show work:

a. Min QE (Q and T) _____ c. Min QE (VT) _____

b. Min safe time (VT) _____

27. *Situation:* You are the safety officer for a 155-mm M109A1 SP howitzer battery firing charge 4 green bag. The battery is laid on azimuth 2150.

a. You have determined the following data:

	Maximum altitude	Minimum altitude
Maximum range	377	368
Intermediate range	341	327
Minimum range	324	320

b. Battery altitude: 339 meters.

c. The following data were taken from the safety card:

.....
Safety limits for 155-mm SP howitzer, shell HE, fuzes M557, M564, and M514.

Left limit: Az 1725

Minimum range: 3,700 meters

Right limit: Az 2535

Maximum range: 7,100 meters

Charge 4 green bag only.

Low-angle fire only

Special instructions: From azimuth 1725 to azimuth 1925 the minimum range is 4,200 meters.

.....
Required: Complete the safety diagram and compute the safety data.

Show work:

DIRECTION OF FIRE

28. *Situation continued:* The battery has completed a precision registration and FDC announces the following registration data:

GFT A: Chg 4, lot XY, Rg 4750, el 260, ti 15.2, df corr R12.

Required: Using these registration corrections, compute the modified safety diagram you will now use. (Use the given data from requirement 27.)

Show work:

DIRECTION OF FIRE

29. *Situation:* You are the safety officer for a 155-mm M109A1 SP howitzer battery firing charges 3 and 4 green bag. The battery is laid on azimuth 5900.

a. You have determined the following data:

	Maximum altitude	Minimum altitude
Maximum range	395	389
Minimum range	388	364

b. Battery altitude: 341 meters.

c. The following data were taken from the range safety card:

.....
Left limit: Azimuth 5580

Minimum range: 5,200 meters

Right limit: Azimuth 6260

Maximum range: 6,900 meters

Charges 3 and 4 white bag only

High-angle fire only
.....

Required: Complete the safety diagram and compute safety data.

Show work:

DIRECTION OF FIRE

30. *Situation:* You are the safety officer for a 155-mm M109A1 SP howitzer battery firing charge 4 green bag. The battery is laid on azimuth 2050.

a. You have determined the following data:

	Maximum altitude	Minimum altitude
Maximum range	377	368
Minimum range	324	320

b. Battery altitude: 339 meters.

c. The following data were taken from the safety card:

.....
Safety limits for 155-mm SP howitzer, shell ICM M449E1

Left limit: Azimuth 1675

Minimum range: 3,600 meters

Right limit: Azimuth 2345

Maximum range: 7,000 meters

Charge 4 green bag only

Low-angle fire only
.....

Required: Complete the safety diagram and compute the safety data.

Show work:

DIRECTION OF FIRE

31. *Situation:* You are the safety officer for a 155-mm M109A1 SP howitzer battery firing charge 4 green bag. The battery is laid on azimuth 2050.

a. You have determined the following data:

	Maximum altitude	Minimum altitude
Maximum range	377	368
Minimum range	385	320

b. Battery altitude: 339 meters.

c. The following data were taken from the range safety card:

.....
Left limit: Azimuth 1675

Maximum range: 7,000 meters

Right limit: Azimuth 2436

Minimum range: 3,600 meters

Charge 4 green bag only

Shell illumination only
.....

Required: Complete the safety diagram and compute safety data:

Show work:

DIRECTION OF FIRE

SECTION III**GRADING KEY**

This grading key is a recommended method of grading this examination. Section I is valued at 55 raw points. Sections I and II together are valued at 200 raw points.

Section I

Item	Cuts per problem	Total weight
(1) True/false	1 point each	15
(2) Multiple choice	2 points each	20
(3) Completion	2 points each	20
		55

Section II

Item	Cuts per problem	Total weight
(1) True/false	1 point each	10
(2) Multiple choice	2 points each	10
(3) Completion	2 points each	20
(4) Performance	Item number: 26	15
	27	25
	28	25
	29	20
	30	10
	31	10

Note. Mathematical errors and expression errors should be assessed a cut of 1 point each.

SECTION I**TEST 1, TRUE AND FALSE**

1. True	6. False	11. True
2. False	7. False	12. True
3. True	8. True	13. True
4. True	9. False	14. True
5. True	10. False	15. True

TEST 2, MULTIPLE CHOICE

16. d	21. c
17. c	22. b
18. a	23. a
19. b	24. d
20. a	25. c

TEST 3, COMPLETION

26. How are white phosphorus projectiles stored? Explain why.

They are stored with their bases down and away from other ammunition to prevent improper settling of the projectile filler.

27. If a VT fuze does not seat properly in the fuze well, what actions should be taken?

The fuze should be removed. Check the round to see if the supplemental charge is still in the fuze well. If it is, remove it, and install the fuze. If it still doesn't seat properly, remove it and turn it in to the ammunition section.

28. The method for placing out safety stakes is as follows:

Set on the sight, in turn, the left, intermediate, and right deflection limits determined from the safety card and take up a proper sight picture on the aiming point. Sight through the breech end of the tube and, sighting along the left edge of the tube for the left limit and the right edge of the tube for the right limit, align the safety stakes.

29. Which of the following sight diagrams illustrate correct sight pictures? Indicate your answer by placing an X in the appropriate spaces provided below.

a. (2)

b. (4)

30. Misfire procedures for the M109/M109A1 howitzer when firing charges 2 through 8, cold tube are: *After a failure to fire, actuate the firing mechanism two additional times in an attempt to fire. If the weapon still fails to fire, wait 2 minutes from the last attempt to fire and then remove and inspect the primer.*

a. If the primer is not dented--the fault is in the firing mechanism. Repair the firing mechanism, prime and then fire the weapon.

b. If the primer is dented--the primer is at fault. Replace the primer with another primer and then fire the piece.

c. If the primer fired--the fault is with the propelling charge. Wait 10 minutes (8 minutes after removal and inspection of the primer), open the breech, and remove and dispose of the defective propelling charge. Reload the weapon with a new propelling charge and primer for firing.

31. Unsafe, deflection exceeds left limit by 10 mils.

32. Unsafe, time is 0.4 second less than minimum time.

33. Unsafe, time is 2.0 seconds less than minimum time.

34. Misfire procedures for the M109/M109A1 howitzer when firing charge 3 hot tube are: *After a failure to fire, actuate the firing mechanism two additional times in an attempt to fire. If the weapon still fails to fire, wait 2 minutes from the last attempt to fire and then remove and inspect the primer.*

a. If the primer is not dented--the fault is in the firing mechanism. Repair the firing mechanism, prime the weapon and then fire it within 5 minutes from the time the round was chambered.

b. If the primer is dented--the primer is at fault. Replace the primer with another primer and then fire the weapon within 5 minutes from the time the round is chambered.

c. *If the primer fired--the fault is with the propelling charge. If it is a combat emergency, insert another primer and then attempt to fire the weapon within 5 minutes from the time the round was chambered.*

d. *If for any reason the projectile is not removed from the tube within 5 minutes of chambering, evacuate all personnel from the weapon and notify EOD or ordnance for removal of the projectile.*

35. Describe the method for measuring the greatest angle of site to a crest in front of the howitzer and list the five methods of determining piece-to-crest range. *Looking through the tube sight along the lowest element of the bore and direct the movement of the tube until the line of sight just clears the highest point on the crest in front of the howitzer. Center the cross-level and pitch-level bubbles and read the elevation, which is the greatest angle of site. The five methods of determining piece-to-crest range are MIL RELATION, TAPING, MAP MEASUREMENT, PACING, and ESTIMATION.*

SECTION II

TEST 1, TRUE AND FALSE

- | | |
|----------|----------|
| 1. True | 6. False |
| 2. True | 7. True |
| 3. False | 8. True |
| 4. True | 9. False |
| 5. True | 10. True |

TEST 2, MULTIPLE CHOICE

- | | |
|-------|-------|
| 11. a | 14. c |
| 12. b | 15. c |
| 13. a | |

TEST 3, COMPLETION

16. Prior to departing for the field, all officers in the chain of command should read and understand five references. They are--

- a. AR 385-63.
- b. FM 6-50, chapter 15.
- c. TM 9-1300-203.
- d. Appropriate FM and TM for the weapon.
- e. Post range regulations.

17. Equipment and material required by the safety officer in the field include--

- a. *Authorized safety card.*
- b. *Applicable tabular firing tables.*
- c. *Applicable graphical firing tables.*
- d. *Applicable graphical site tables.*
- e. *Map of the area.*
- f. *Aiming circle.*

18. Upon arrival at the prescribed firing point, the safety officer must check and verify the following:

- a. *Verify that the safety card applies to the firing unit, exercise, and date.*
- b. *Verify that the battery is in the position as specified on the card.*
- c. *Verify the boresighting of each weapon.*
- d. *Verify the laying of the battery.*

19. To properly orient his aiming circle when the battery is laid by the grid azimuth method, the safety officer must insure that his aiming circle is no closer than 75 meters to artillery weapons.

20. The battery has been laid on an azimuth of 430 mils. You are preparing to check the lay. The declination constant of your aiming circle is 300 mils. What instrument reading would you place on the scales by use of the upper motion when you are preparing to orient your aiming circle on the azimuth of fire? *6,100 mils.*

21. If a VT fuze does not seat properly in the fuze well, what actions should be taken? *Remove the fuze and check to see if the supplemental charge is still in the fuze well. If it is, remove it and install the fuze. Then if the fuze does not seat properly, remove it and turn it in to the ammunition section.*

22. Describe the procedures for burning unused powder increments.

The burning site will be at least 200 feet from personnel and equipment. All powder charge increments to be destroyed should be placed in a single-layer row not more than 12 inches wide. The row of increments should be placed so that burning will progress into the direction of the wind. A train of combustible material approximately 15 feet long should be placed perpendicular to, and at the downwind end of, the row of increments. The combustible materials should be lighted at the end farthest from the explosive train side of the train. Igniter powder (red devils) and flash reducers will be placed at the upwind end of the row of increments to be destroyed.

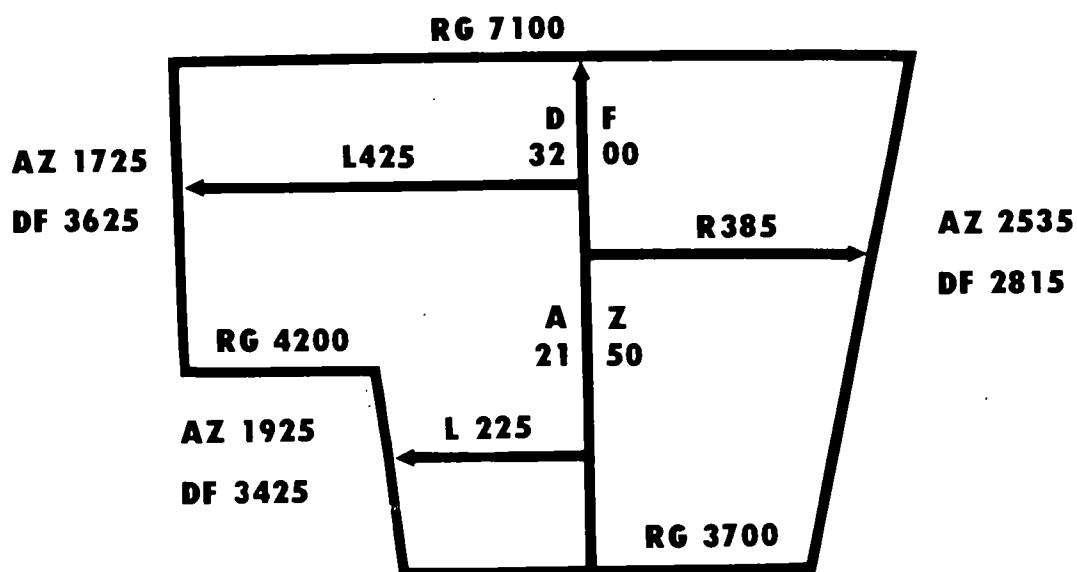
23. At a firing point, how do you verify the declination constant on the aiming circle? *Set up the aiming circle over any point from which the azimuth to another visible point is known. Using the upper motion, set the known azimuth on the scales. Using the lower motion, sight on the known point. Release the magnetic needle, and using the upper motion, center it. Read the value on the scales and compare it to the declination constant. If the two values compare within ± 2 mils, the declination constant is valid. If not, the aiming circle should be redeclinated in accordance with FM 6-2.*

24. How does the safety officer verify the initial lay of the battery at a firing point? *A declinated aiming circle, oriented on the azimuth of lay, will be set up at least 10 meters away from the executive officer's aiming circle. Referred readings will be taken between the two aiming circles and they must agree with the criteria dictated by local range regulations/unit SOP. The safety officer will command the pieces to refer to his aiming circle after the weapon aiming points have been established. The referred readings between the safety officer's aiming circle and the pieces must agree with criteria established by local range regulations/unit SOP.*

25. Describe the procedures used by the safety officer using the testing target method to verify that the panoramic telescope and the direct fire telescope of each howitzer are alined parallel

Requirement 27, Weight 25

1. Diagram construction
 2. Deflection and azimuth —1 ea,
 3. Dog leg positioning —3
 4. Expression errors —1
 5. Math errors —1
- } Maximum cuts —6

DF OTHER THAN 3200 -3

CHG	RG	ALT USED	VI	SI	EL	QE	TI M564	TI FL	TI M514
4	7100	368	+29	+6	489	495			
4	4200	341	+2	+1	238	239	14.5	14.7 + 5.5	=20.2 = 21.0
4	3700	324	-15	-4	205	201	12.6	12.7 + 5.5	=18.2 = 19.0
			CUT:	-2 EA	-1 EA		-2 EA		-3 EA
				MAX -6	MAX -3		MAX -4		MAX -6

Requirement 28, Weight 25 points

Diagram: Df and Az — 2 each, Maximum cuts — 6

Failure to use GFT setting —15

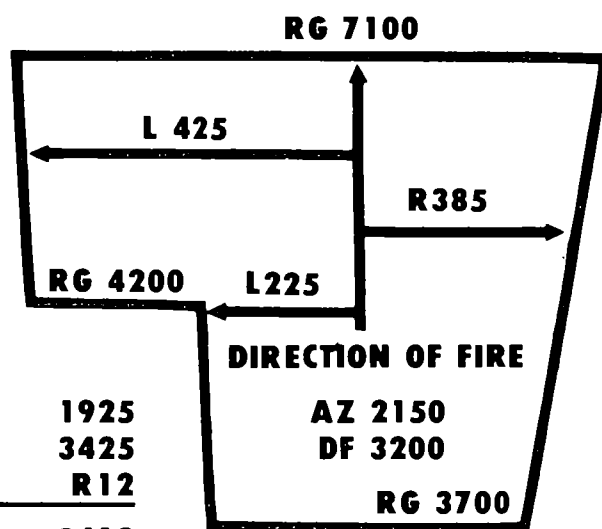
Ti M514, did not apply 5.5 — 2

Expression —1, Maximum — 2

Math error — 1

DF OTHER THAN 3200 -3

AZ 1725
DF 3625
DF CORR R12
DF 3613



AZ 2535
DF 2815
DF CORR R12
DF 2803

AZ 1925
DF 3425
DF CORR R12
DF 3413

RG	SI	EL	QE	TI M564	TI FL	TI M514
7100	+ 6	450	456			
4200	+ 1	225	226	13.2	13.9 + 5.5 =	19.4 = 20.0
3700	- 4	194	190	11.5	12.0 + 5.5 =	17.5 = 18.0
	-1 EA	-2 EA		=1 EA		-3 EA
	MAX -3	MAX -6		MAX -2		MAX -6

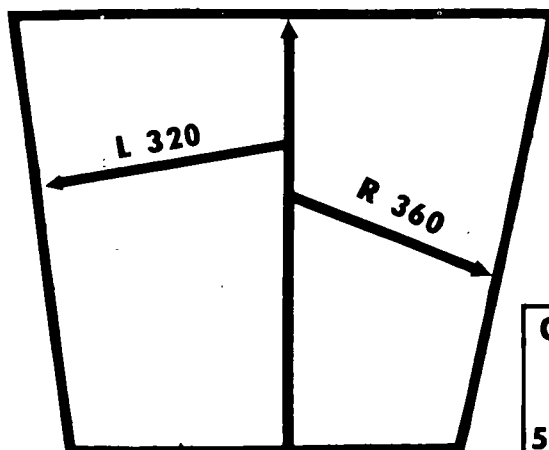
Requirement 29, Weight 20 points

Diagram Df and Az —2 ea Maximum cuts —4
 Drift —2 ea Maximum cuts —4
 Math errors —1
 Expression errors —1

DF TO OTHER THAN 3200 -3

AZ 5900
DF 3200

AZ 5580
DF 3520
DFT L32
DF 3552



AZ 6260
DF 2840
DFT L91
DF 2919

COMPUTATION OF DRIFT

CHG 3 CHG 4

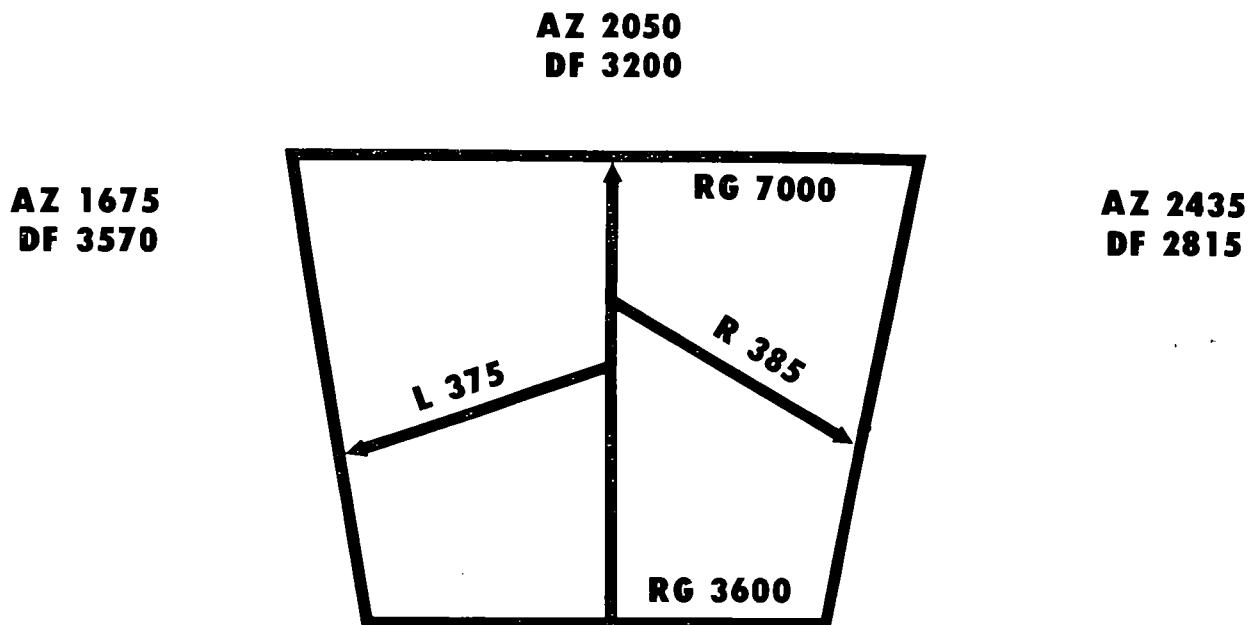
5200 L 62 **L 91**
 L 32 L 49

CHG	RG	EL	ANGLE OF SITE	10m SI FAC	SI	QE
4	6900	1089	+ 7	- 3.7	-3	1086
4	5200	1235	+ 9	- 1.0	-1	1234
3	6900	SAFE				
3	5200	1123	+ 9	- 2.8	-3	1120
		(-2 EA)			(-2 EA)	
		MAX -6			MAX -6	

MAXIMUM CUT FOR COMPLETE PROBLEM -20

Requirement 30, Weight 10 points

1. Diagram: Df and Az —1 ea, Maximum cut —2
2. Expression errors —1
3. Math errors —1 ea

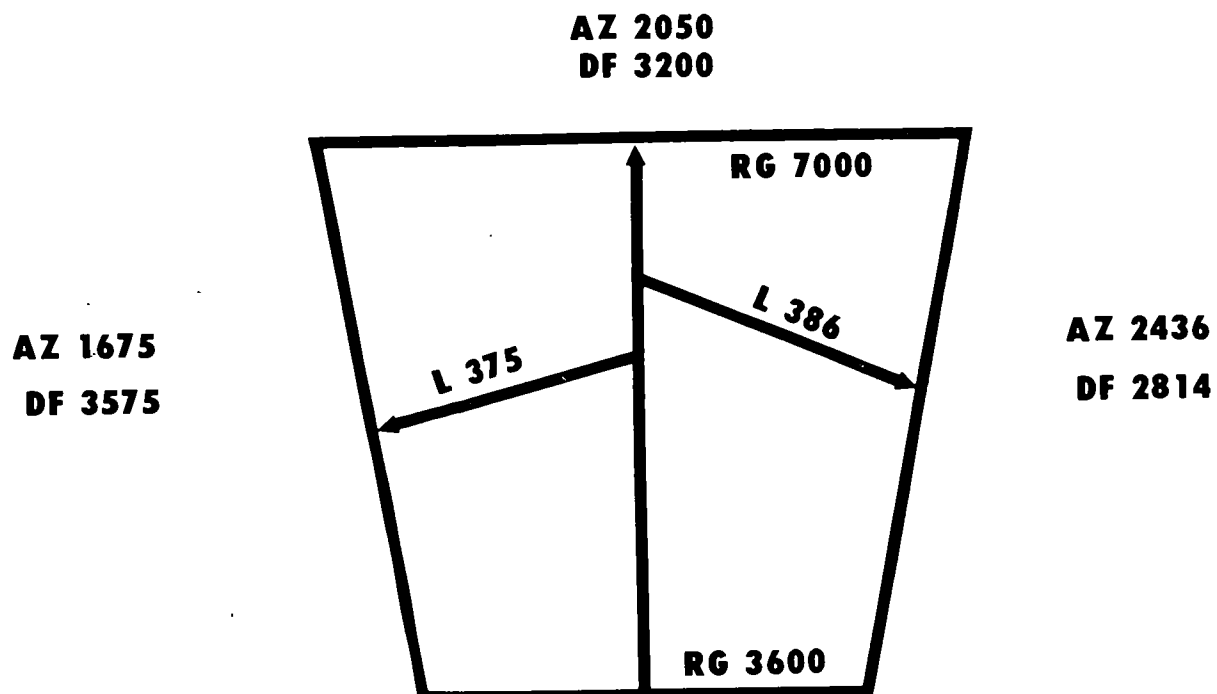


CHG	RG	RG TO IMPACT	ENTRY QE	CORR ICM	SI	QE	M564 TI
4	7000	6982	470	+ 28	+6	484	
4	3600		195	+ 74		269	12.2
			(- 1 ea)	(- 1 ea)		(- 1 ea)	(- 2)

ENTIRE PROBLEM MAXIMUM CUTS -10

Requirement 31, Weight 10 points

1. Diagram: Df and Az
—1 ea Max cut —2 pts
2. Expression errors —1
3. Math errors —1



CHG	RG	RG IMPACT	MIN ALT	BTRY ALT	VI	SI		EL	QE
4GB	7000	6989	368	339	+29	+ 6		484	490
						(-1)		(-1)	(-1)
CHG	RG	MAX ALT	ALT BTRY	QE	Δ QE	INCREMENTS	CHANGE	QE	M564 TI
4GB	3600	385	339	427.5	14.2	X 14 =	198.8	229	12.2
				(-1)			(-1)	(-1)	(-2)

MAXIMUM CUT FOR COMPLETE PROBLEM -10



APPENDIX F

MINIMUM QE RAPID FIRE TABLES

F-1. General

These rapid fire tables include all the elements of the minimum QE discussed in chapter 10 *except* angle α (site to crest). Separate tables are included for each weapon/fuze/propellant combination. The value listed for elevation (EL) in all tables is the sum of the tabular firing table (TFT) elevation, 2 forks, the vertical angle corresponding to the appropriate vertical clearance, and the complementary angle of site for +300 mils angle of site. If the sum of angles is greater than 300 mils, you will have to compute the data as shown in chapter 10.

The time (TI) listed in the VT fuze tables includes the TFT time of flight plus 5.5 seconds, expressed to the next higher whole second (min safe time) for each listed range. When the time set on the VT fuze is equal to or greater than the time listed in the table, the minimum quadrant elevation for fuzes *other than* VT is used. Vertical clearance for armed VT fuzes was determined with the vertical clearances prescribed for the M513 and M514 fuzes. If the M728 or M514A3 fuze is being used, the computations in section II, chapter 10 must be used.

F-2. Use of the Tables

Here's how to use the rapid fire tables:

- a. Enter the table at the piece-to-crest range and determine the minimum elevation for the appropriate charge(s).
- b. Select the greatest angle of site reported by the chiefs of section.
- c. Add these two values. The sum is the minimum quadrant elevation.

EXAMPLE: 155-mm howitzer M109A1 range to the crest is 900 meters. Angles of site reported by the chiefs of section are +80, +78, +74, +68, +72, +79. Determine the minimum quadrant elevation for charge 5 white bag, fuze M564.

SOLUTION: Enter table V at range 900 meters.

Value from the table for charge 5	40.
Greatest angle of site reported	+80 mils
Minimum quadrant elevation	+120 mils

THERE ARE RESTRICTIONS ON THE USE OF THE VT FUZE WHEN FIRING CERTAIN CHARGES ON SOME WEAPON SYSTEMS. THESE AREAS ARE INDICATED ON THE TABLES BY SHADING. FOR THE SPECIFIC RESTRICTIONS REFER TO THE WEAPON USER'S MANUAL AND/OR TM 9-1300-203.

RAPID FIRE TABLE I PROPELLANT M67

WEAPON M101A1

Range to Crest	FUZE M557, M564							Range to Crest					
	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7		CHG 3	CHG 4	CHG 5	CHG 6	CHG 7
100	69	66	64	62	60	57	56	3700	603	396	269	193	134
200	57	52	48	44	41	36	33	3800	626	409	279	199	139
300	61	54	48	42	37	31	27	3900	647	421	287	207	143
400	73	61	54	46	39	31	25	4000	671	435	295	212	148
500	84	73	61	51	42	33	26	4500		541	350	245	173
600	100	87	73	58	46	36	27	5000		709	413	284	201
700	115	97	81	64	51	39	29	5500			490	324	229
800	128	108	90	73	55	43	30	6000			593	370	259
900	141	121	99	80	60	46	32	6500			757	423	292
1000	157	133	108	87	66	50	35	7000				488	329
1100	180	150	123	96	73	54	37	7500				569	369
1200	196	165	133	104	81	58	39	8000				684	414
1300	211	176	143	111	86	62	41	8500					465
1400	226	189	153	119	92	66	44	9000					529
1500	243	204	165	129	98	71	47	9500					609
1600	276	227	183	141	106	77	50	10000					734
1700	294	241	193	149	111	81	52						
1800	312	255	203	157	117	85	56						
1900	329	269	216	165	123	90	59						
2000	349	285	228	176	129	95	62						
2100	403	317	249	190	140	103	67						
2200	422	334	262	199	146	108	70						
2300	443	351	274	208	153	113	74						
2400	465	367	288	219	159	118	77						
2500	489	385	300	228	166	123	81						
2600	619	439	328	244	175	128	85						
2700	644	456	342	254	182	134	89						
2800	673	476	355	265	191	139	92						
2900	706	496	371	275	198	144	98						
3000	742	517	384	285	205	149	102						
3100	783	646	430	309	217	157	107						
3200		670	447	319	224	162	112						
3300		696	462	329	233	168	116						
3400		725	479	342	240	173	120						
3500		757	497	352	247	179	124						
3600		795	584	384	262	187	130						

RAPID FIRE TABLE I **PROPELLANT M67**

FUZE M513

WEAPON M101A1

Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		CHG 6		CHG 7	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	264	8.0	225	8.0	213	8.0	184	8.0	173	8.0	148	8.0	117	8.0
200	264	8.0	225	8.0	213	8.0	184	8.0	173	8.0	148	8.0	117	8.0
300	264	8.0	225	8.0	213	8.0	184	8.0	173	8.0	148	8.0	117	8.0
400	264	8.0	225	8.0	213	8.0	184	8.0	173	8.0	148	8.0	117	8.0
500	236	9.0	225	8.0	213	8.0	184	8.0	173	8.0	148	8.0	117	8.0
600	227	9.0	214	9.0	200	9.0	184	8.0	173	8.0	148	8.0	117	8.0
700	224	10.0	206	9.0	190	9.0	173	9.0	160	8.0	148	8.0	117	8.0
800	223	10.0	203	10.0	185	9.0	168	9.0	150	9.0	138	8.0	117	8.0
900	226	11.0	206	10.0	184	10.0	165	9.0	145	9.0	131	9.0	117	8.0
1000	233	11.0	209	11.0	184	10.0	163	10.0	142	9.0	126	9.0	111	8.0
1100	250	12.0	220	11.0	193	11.0	166	10.0	143	10.0	124	9.0	107	8.0
1200	259	12.0	228	12.0	196	11.0	167	11.0	144	10.0	121	9.0	102	9.0
1300	270	13.0	235	12.0	202	12.0	170	11.0	145	10.0	121	10.0	100	9.0
1400	281	14.0	244	13.0	208	12.0	174	11.0	147	11.0	121	10.0	99	9.0
1500	294	14.0	255	13.0	216	13.0	180	12.0	149	11.0	122	10.0	98	10.0
1600	323	15.0	274	14.0	230	13.0	188	12.0	153	11.0	124	11.0	97	10.0
1700	339	15.0	286	14.0	238	14.0	194	13.0	156	12.0	126	11.0	97	10.0
1800	355	16.0	298	15.0	246	14.0	200	13.0	160	12.0	128	11.0	99	10.0
1900	369	17.0	309	16.0	256	15.0	205	14.0	163	13.0	130	12.0	99	11.0
2000	387	17.0	323	16.0	266	15.0	214	14.0	167	13.0	133	12.0	100	11.0
2100	439	18.0	353	17.0	285	16.0	226	14.0	176	13.0	139	12.0	103	11.0
2200	457	19.0	369	17.0	297	16.0	234	15.0	181	14.0	143	13.0	105	11.0
2300	476	19.0	384	18.0	307	17.0	241	15.0	186	14.0	146	13.0	107	12.0
2400	496	20.0	398	19.0	319	17.0	250	16.0	190	14.0	149	13.0	108	12.0
2500	519	21.0	415	19.0	330	18.0	258	16.0	196	15.0	153	14.0	111	12.0
2600	649	21.0	469	20.0	358	18.0	274	17.0	205	15.0	158	14.0	115	13.0
2700	673	22.0	485	20.0	371	19.0	283	17.0	213	16.0	163	14.0	118	13.0
2800	701	23.0	504	21.0	383	19.0	293	18.0	219	16.0	167	15.0	120	13.0
2900	733	24.0	523	22.0	398	20.0	302	18.0	225	16.0	171	15.0	125	14.0
3000	768	25.0	543	23.0	410	21.0	311	19.0	231	17.0	175	15.0	128	14.0
3100			671	23.0	455	21.0	334	19.0	242	17.0	182	16.0	132	14.0
3200			694	24.0	471	22.0	343	20.0	248	18.0	186	16.0	136	15.0
3300			719	25.0	485	22.0	352	20.0	256	18.0	191	16.0	139	15.0
3400			747	26.0	501	23.0	364	21.0	262	18.0	195	17.0	142	15.0

FUZE M513

WEAPON M101A1

[illegible]

RAPID FIRE TABLE II **PROPELLANT M67**

FUZE M557, M564

WEAPON M102

Range to Crest	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7	Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7
100	67	65	63	61	59	58	57	3700	472	331	227	176	117
200	54	50	46	42	39	36	34	3800	488	340	234	181	123
300	58	51	45	40	35	30	27	3900	502	352	240	187	128
400	68	57	50	43	36	30	25	4000	519	362	247	192	132
500	78	68	56	47	39	31	25	4500	690	436	290	227	157
600	91	79	65	53	42	33	25	5000		531	337	257	180
700	105	89	74	59	46	36	27	5500		670	387	298	208
800	116	98	82	64	50	38	28	6000			450	334	234
900	128	110	89	70	54	41	29	6400			527	389	270
1000	143	121	98	77	59	45	31	7000			633	430	299
1100	162	136	109	86	64	49	33	7500				516	340
1200	177	147	118	93	69	53	36	8000				565	375
1300	190	159	128	99	74	56	37	8500					431
1400	205	170	137	106	79	60	40	9000					471
1500	219	182	146	113	84	64	43	9500					561
1600	248	203	159	124	91	69	45	10000					609
1700	262	214	170	130	95	72	47						
1800	278	226	179	137	101	76	50						
1900	293	240	189	147	106	81	53						
2000	310	252	199	154	112	85	56						
2100	349	280	218	166	119	92	60						
2200	367	293	228	173	125	97	63						
2300	385	308	238	181	131	101	66						
2400	404	321	249	189	136	106	69						
2500	424	337	261	199	144	111	72						
2600	493	372	282	212	152	115	75						
2700	514	389	292	220	158	119	78						
2800	536	403	305	228	164	124	81						
2900	558	421	316	236	170	129	85						
3000	584	438	328	245	176	134	88						
3100		503	359	263	185	142	94						
3200		522	371	270	191	148	98						
3300		541	385	281	198	155	102						
3400		562	398	289	204	160	105						
3500		583	413	300	210	165	109						
3600			457	322	221	171	113						

RAPID FIRE TABLE II PROPELLANT M67

FUZE M513

WEAPON M102

Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		CHG 6		CHG 7	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	259	8.0	220	8.0	208	8.0	180	8.0	155	8.0	133	8.0	108	8.0
200	259	8.0	220	8.0	208	8.0	180	8.0	155	8.0	133	8.0	108	8.0
300	259	8.0	220	8.0	208	8.0	180	8.0	155	8.0	133	8.0	108	8.0
400	259	8.0	220	8.0	208	8.0	180	8.0	155	8.0	133	8.0	108	8.0
500	230	8.0	220	8.0	208	8.0	180	8.0	155	8.0	133	8.0	108	8.0
600	218	9.0	206	9.0	194	8.0	180	8.0	155	8.0	133	8.0	108	8.0
700	214	9.0	198	9.0	183	9.0	168	9.0	155	8.0	133	8.0	108	8.0
800	211	10.0	193	10.0	177	9.0	159	9.0	145	8.0	133	8.0	108	8.0
900	213	10.0	195	10.0	174	10.0	155	9.0	139	9.0	126	8.0	108	8.0
1000	219	11.0	197	11.0	174	10.0	153	10.0	135	9.0	121	9.0	108	8.0
1100	232	11.0	206	11.0	179	11.0	156	10.0	134	9.0	119	9.0	103	8.0
1200	240	12.0	210	12.0	181	11.0	156	10.0	132	10.0	116	9.0	99	9.0
1300	249	13.0	218	12.0	187	11.0	158	11.0	133	10.0	115	10.0	96	9.0
1400	260	13.0	225	12.0	192	12.0	161	11.0	133	10.0	115	10.0	95	9.0
1500	270	14.0	233	13.0	197	12.0	164	12.0	135	11.0	115	10.0	94	9.0
1600	295	14.0	250	13.0	206	13.0	171	12.0	138	11.0	115	10.0	92	10.0
1700	307	15.0	259	14.0	215	13.0	175	12.0	140	11.0	116	11.0	92	10.0
1800	321	15.0	269	15.0	222	14.0	180	13.0	144	12.0	119	11.0	93	10.0
1900	333	16.0	280	15.0	229	14.0	187	13.0	146	12.0	120	11.0	93	10.0
2000	348	16.0	290	16.0	237	15.0	192	14.0	150	12.0	123	12.0	94	11.0
2100	385	17.0	316	16.0	254	15.0	202	14.0	155	13.0	127	12.0	96	11.0
2200	402	18.0	328	17.0	263	15.0	208	14.0	160	13.0	131	12.0	98	11.0
2300	418	18.0	341	17.0	271	16.0	214	15.0	164	14.0	134	13.0	99	11.0
2400	435	19.0	352	18.0	280	16.0	220	15.0	167	14.0	136	13.0	100	12.0
2500	454	20.0	367	18.0	291	17.0	229	16.0	174	14.0	140	13.0	102	12.0
2600	523	20.0	402	19.0	312	17.0	242	16.0	182	15.0	144	14.0	105	12.0
2700	543	21.0	418	19.0	321	18.0	249	16.0	187	15.0	148	14.0	107	13.0
2800	564	22.0	431	20.0	333	18.0	256	17.0	192	15.0	152	14.0	109	13.0
2900	585	22.0	448	21.0	343	19.0	263	17.0	197	16.0	156	15.0	112	13.0
3000	610	23.0	464	21.0	354	19.0	271	18.0	202	16.0	160	15.0	114	13.0
3100			528	22.0	384	20.0	288	18.0	210	16.0	167	15.0	119	14.0
3200			546	23.0	395	20.0	296	19.0	215	17.0	171	16.0	122	14.0
3300			564	23.0	408	21.0	304	19.0	221	17.0	177	16.0	125	14.0
3400			584	24.0	420	22.0	312	20.0	226	18.0	182	16.0	127	15.0
3500			605	25.0	435	22.0	322	20.0	232	18.0	187	17.0	131	15.0
3600			793	25.0	478	23.0	343	20.0	242	18.0	191	17.0	134	15.0
3700					493	23.0	352	21.0	248	19.0	197	17.0	138	16.0

RAPID FIRE TABLE II **PROPELLANT M67**

FUZE M513

Range to Crest	CHG 3	
	EL	TI
3800	508	24.0
3900	521	25.0
4000	538	25.0
4500	707	29.0
5000		
5500		
6000		
6500		
7000		
7500		
8000		
8500		
9000		
9500		
10000		

CHG 4	
EL	TI
360	21.0
371	22.0
381	22.0
453	25.0
546	28.0
684	31.0

CHG 5	
EL	TI
254	19.0
259	20.0
266	20.0
307	22.0
352	24.0
401	26.0
463	29.0
539	31.0
644	34.0

WEAPON M102

CHG 6	
EL	TI
201	18.0
206	18.0
211	19.0
243	20.0
271	22.0
312	24.0
346	26.0
401	28.0
440	31.0
526	33.0
575	36.0

CHG 7	
EL	TI
143	16.0
147	16.0
151	17.0
174	18.0
195	20.0
222	22.0
247	24.0
282	25.0
310	27.0
350	29.0
385	32.0
440	34.0
480	36.0
569	39.0
617	42.0

RAPID FIRE TABLE III **PROPELLANT GREEN BAG M3**

WEAPON M114A1

FUZE M557, M564										
Range to Crest	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5	Range to Crest	CHG 2	CHG 3	CHG 4	CHG 5
100	67	64	61	60	57	3400	456	314	220	162
200	54	48	43	40	36	3500	471	325	229	169
300	57	48	41	36	31	3600	539	349	242	177
400	65	53	45	37	31	3700	557	359	249	182
500	77	61	50	41	32	3800	575	372	256	187
600	90	70	56	44	35	3900	595	382	263	193
700	101	80	62	48	38	4000	617	393	270	200
800	112	89	68	53	41	4500	753	479	316	230
900	125	97	75	57	44	5000		594	371	265
1000	138	107	84	63	48	5500			430	300
1100	156	120	92	69	51	6000			505	342
1200	170	132	100	75	56	6500			606	387
1300	182	141	106	79	59	7000				439
1400	196	151	114	85	63	7500				501
1500	211	161	122	91	68	8000				576
1600	237	179	132	99	73	8500				682
1700	251	189	141	104	76					
1800	265	199	149	110	81					
1900	280	210	157	116	86					
2000	296	223	165	122	90					
2100	331	242	178	130	96					
2200	348	254	186	135	99					
2300	366	267	197	141	108					
2400	392	278	205	147	112					
2500	401	290	213	154	117					
2600	460	318	228	163	122					
2700	479	330	237	171	127					
2800	500	342	247	177	132					
2900	521	357	256	184	137					
3000	543	370	265	190	142					
3100	696	400	283	201	149					
3200	720	424	295	207	154					
3300	748	439	304	214	159					

RAPID FIRE TABLE III
FUZE M557, M564 PROPELLANT WHITE BAG M4A1 WEAPON M114A1

Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7	Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7
100	61	59	57	56	55	3400	307	216	164	113	73
200	43	39	56	33	32	3500	317	225	169	116	75
300	41	36	30	27	24	3600	338	236	178	121	78
400	43	37	30	25	22	3700	349	243	183	125	82
500	48	40	32	25	22	3800	361	250	189	129	85
600	56	43	35	27	21	3900	371	259	194	133	87
700	62	47	38	29	22	4000	383	265	199	137	90
800	68	51	41	30	23	4500	461	310	230	162	105
900	74	58	43	32	23	5000	561	361	265	186	119
1000	83	63	48	34	25	5500	711	419	301	213	138
1100	91	68	51	36	27	6000		488	342	237	155
1200	98	74	55	39	29	6400		576	386	268	177
1300	104	78	60	40	30	7000		703	437	298	188
1400	114	83	65	43	31	7500			497	333	222
1500	121	89	69	46	33	8000			571	371	246
1600	131	96	74	49	35	8500			673	411	272
1700	138	103	78	51	36	9000				458	301
1800	147	109	82	54	38	9500				512	330
1900	155	114	87	57	40	10000				577	362
2000	162	120	91	60	42	10500				661	398
2100	176	128	97	64	44	11000					437
2200	184	133	102	68	46	11500					480
2300	192	139	106	71	48	12000					530
2400	202	147	111	76	50	12500					591
2500	210	153	118	79	52	13000					669
2600	223	161	123	82	54						
2700	233	167	128	86	56						
2800	241	173	132	89	58						
2900	250	181	137	92	60						
3000	260	187	142	96	62						
3100	277	197	148	100	66						
3200	288	204	153	103	67						
3300	296	210	159	107	70						

FUZE M514

**RAPID FIRE TABLE III
PROPELLANT WHITE BAG M4A1**

WEAPON M114A1

Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7		Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	217	8.0	185	8.0	162	8.0	140	8.0	115	8.0	3400	335	20.0	244	18.0	192	16.0	141	15.0	101	13.0
200	217	8.0	185	8.0	162	8.0	140	8.0	115	8.0	3500	345	20.0	253	18.0	197	17.0	144	15.0	102	13.0
300	217	8.0	185	8.0	162	8.0	140	8.0	115	8.0	3600	365	21.0	263	19.0	205	17.0	148	15.0	105	14.0
400	217	8.0	185	8.0	162	8.0	140	8.0	115	8.0	3700	375	21.0	269	19.0	209	17.0	151	16.0	108	14.0
500	217	8.0	185	8.0	162	8.0	140	8.0	115	8.0	3800	386	22.0	276	19.0	214	18.0	154	16.0	110	14.0
600	217	8.0	185	8.0	162	8.0	140	8.0	115	8.0	3900	396	22.0	284	20.0	219	18.0	158	16.0	111	14.0
700	200	9.0	162	8.0	162	8.0	140	8.0	115	8.0	4000	407	23.0	289	20.0	220	19.0	161	17.0	114	15.0
800	189	9.0	172	9.0	162	8.0	140	8.0	115	8.0	4500	482	25.0	331	22.0	251	20.0	183	18.0	126	16.0
900	182	9.0	166	9.0	152	8.0	140	8.0	115	8.0	5000	580	28.0	380	24.0	284	22.0	205	20.0	138	17.0
1000	179	10.0	159	9.0	144	9.0	130	8.0	115	8.0	5500	728	31.0	436	27.0	318	24.0	230	22.0	155	19.0
1100	179	10.0	156	10.0	139	9.0	124	8.0	115	8.0	6000			504	29.0	358	26.0	253	23.0	171	20.0
1200	178	10.0	154	10.0	136	9.0	119	9.0	109	8.0	6500			591	32.0	401	28.0	283	25.0	192	22.0
1300	179	11.0	153	10.0	135	10.0	115	9.0	105	8.0	7000			717	35.0	451	30.0	312	27.0	212	24.0
1400	183	11.0	152	11.0	134	10.0	112	9.0	100	9.0	7500					510	33.0	346	29.0	235	25.0
1500	185	12.0	153	11.0	133	10.0	110	9.0	97	9.0	8000					583	36.0	383	31.0	258	27.0
1600	191	12.0	156	11.0	134	11.0	109	10.0	95	9.0	8500					684	38.0	422	33.0	283	29.0
1700	195	12.0	160	12.0	135	11.0	108	10.0	93	9.0	9000					655	42.0	469	35.0	312	31.0
1800	201	13.0	163	12.0	136	11.0	108	10.0	92	9.0	9500							522	38.0	340	33.0
1900	206	13.0	165	12.0	138	12.0	108	10.0	91	10.0	10000							587	40.0	372	34.0
2000	210	14.0	168	13.0	139	12.0	108	11.0	90	10.0	10500							670	43.0	407	37.0
2100	222	14.0	174	13.0	143	12.0	110	11.0	90	10.0	11000							699	46.0	446	39.0
2200	230	14.0	177	13.0	146	12.0	113	11.0	90	10.0	11500									488	41.0
2300	234	15.0	181	14.0	148	13.0	114	12.0	90	10.0	12000									538	43.0
2400	242	15.0	187	14.0	151	13.0	116	12.0	90	11.0	12500									599	46.0
2500	248	16.0	191	14.0	156	13.0	117	12.0	90	11.0	13000									675	49.0
2600	261	16.0	199	15.0	161	14.0	120	12.0	92	11.0	13500									786	52.0
2700	269	17.0	203	15.0	164	14.0	122	13.0	92	11.0											
2800	276	17.0	208	15.0	167	14.0	124	13.0	93	12.0											
2900	284	17.0	215	16.0	171	15.0	126	13.0	94	12.0											
3000	292	18.0	219	16.0	174	15.0	128	14.0	94	12.0											
3100	308	18.0	228	17.0	179	15.0	131	14.0	97	12.0											
3200	318	19.0	234	17.0	183	16.0	133	14.0	98	13.0											
3300	325	19.0	239	17.0	188	16.0	136	14.0	99	13.0											

RAPID FIRE TABLE IV **PROPELLANT GREEN BAG M3A1**

WEAPON M109

Range to Crest	FUZE M557, M564					Range to Crest				
	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5		CHG 2	CHG 3	CHG 4	CHG 5
100	67	63	61	59	57	3300	430	278	201	157
200	53	47	43	39	36	3400	444	287	206	162
300	56	48	40	36	30	3500	460	298	216	167
400	63	53	43	37	30	3600	521	318	227	175
500	75	60	48	40	32	3700	538	327	234	180
600	89	71	53	43	35	3800	556	336	240	185
700	101	79	59	47	38	3900	574	347	247	191
800	114	88	65	51	41	4000	594	357	254	196
900	125	96	71	55	44	4500		428	296	227
1000	138	106	78	61	48	5000		507	343	261
1100	157	119	85	66	51	5500		638	395	295
1200	170	129	92	71	55	6000			460	335
1300	182	138	98	76	58	6500			528	378
1400	197	148	107	81	63	7000			642	427
1500	211	160	114	86	69	7500				485
1600	237	176	124	93	73	8000				557
1700	250	185	131	97	76	8500				651
1800	266	196	138	103	81					
1900	280	208	145	108	85					
2000	297	219	153	114	90					
2100	331	238	164	123	95					
2200	348	251	172	128	100					
2300	365	262	182	136	105					
2400	381	273	189	142	110					
2500	400	286	197	148	114					
2600	457	311	210	155	119					
2700	476	325	218	160	124					
2800	497	337	226	166	129					
2900	517	351	234	173	134					
3000	539	364	245	179	141					
3100	681	401	261	189	147					
3200	705	414	269	195	152					

RAPID FIRE TABLE IV **PROPELLANT WHITE BAG M4A2**

FUZE M557, 564

WEAPON M109

Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7	Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7
100	61	60	57	56	55	3500	324	224	170	116	76
200	43	40	36	33	32	3600	345	236	178	121	78
300	41	36	30	27	24	3700	355	243	183	125	81
400	44	37	30	25	22	3800	367	249	188	129	83
500	49	40	32	26	22	3900	377	258	194	133	86
600	55	43	35	27	21	4000	389	265	199	137	89
700	63	48	38	29	22	4500	470	309	230	162	106
800	69	52	41	30	23	5000	577	360	265	186	121
900	76	56	44	32	23	5500		414	298	210	138
1000	81	62	48	34	25	6000		483	339	238	158
1100	91	69	51	36	27	6500		567	383	267	180
1200	100	74	56	39	29	7000		686	432	297	202
1300	107	79	59	41	30	7500			492	332	226
1400	114	84	63	43	31	8000			565	367	248
1500	122	90	68	46	33	8500			664	408	278
1600	134	97	75	49	35	9000				453	303
1700	141	102	78	51	36	9500				506	340
1800	149	108	83	54	38	10000				569	367
1900	156	113	88	57	40	10500				651	408
2000	166	121	92	60	42	11000					440
2100	178	129	98	64	44	11500					497
2200	186	135	103	68	46	12000					535
2300	194	140	107	71	48	12500					628
2400	204	146	112	74	50	13000					673
2500	213	152	117	77	52						
2600	227	160	122	83	54						
2700	237	168	127	86	56						
2800	246	174	132	90	58						
2900	255	180	137	93	60						
3000	265	187	142	97	63						
3100	283	196	147	101	66						
3200	292	202	153	104	68						
3300	303	211	160	108	71						
3400	313	217	165	112	73						

FUZE M514

RAPID FIRE TABLE IV
PROPELLANT WHITE BAG M4A2

WEAPON M109

Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7		Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	216	8.0	186	8.0	176	8.0	140	8.0	115	8.0	3400	341	20.0	245	16.0	193	16.0	140	15.0	101	13.0
200	216	8.0	186	8.0	176	8.0	140	8.0	115	8.0	3500	352	20.0	252	17.0	198	17.0	144	15.0	104	13.0
300	216	8.0	186	8.0	176	8.0	140	8.0	115	8.0	3600	372	21.0	263	17.0	205	17.0	148	15.0	105	14.0
400	216	8.0	186	8.0	176	8.0	140	8.0	115	8.0	3700	381	21.0	269	18.0	209	18.0	151	16.0	107	14.0
500	216	8.0	186	8.0	176	8.0	140	8.0	115	8.0	3800	392	22.0	274	18.0	213	18.0	154	16.0	108	14.0
600	216	8.0	186	8.0	176	8.0	140	8.0	115	8.0	3900	402	22.0	283	18.0	219	18.0	158	16.0	111	14.0
700	201	9.0	186	8.0	176	8.0	140	8.0	115	8.0	4000	413	23.0	289	19.0	223	19.0	161	17.0	113	15.0
800	190	9.0	173	8.0	162	8.0	140	8.0	115	8.0	4500	491	23.0	330	20.0	251	20.0	183	18.0	127	16.0
900	184	9.0	164	8.0	152	8.0	140	8.0	115	8.0	5000	596	24.0	379	22.0	284	22.0	205	20.0	140	17.0
1000	177	10.0	158	9.0	144	9.0	130	8.0	115	8.0	5500			432	24.0	316	24.0	228	22.0	156	19.0
1100	179	10.0	157	9.0	139	9.0	124	8.0	115	8.0	6000			499	26.0	355	26.0	254	24.0	174	21.0
1200	180	11.0	154	9.0	136	9.0	119	9.0	109	8.0	6500			581	28.0	398	30.0	282	25.0	195	22.0
1300	182	11.0	154	10.0	134	10.0	116	9.0	105	8.0	7000			700	30.0	446	30.0	311	27.0	216	24.0
1400	183	11.0	153	10.0	132	10.0	112	9.0	100	9.0	7500					505	33.0	345	29.0	239	26.0
1500	186	12.0	154	10.0	132	10.0	110	9.0	97	9.0	8000					577	35.0	379	31.0	260	27.0
1600	194	12.0	157	11.0	135	11.0	109	10.0	95	9.0	8500					675	38.0	419	33.0	289	29.0
1700	198	13.0	159	11.0	135	11.0	108	10.0	93	9.0	9000							464	35.0	314	31.0
1800	203	13.0	162	11.0	137	11.0	108	10.0	92	9.0	9500							516	38.0	350	33.0
1900	207	13.0	164	12.0	139	12.0	108	11.0	91	10.0	10000							579	40.0	378	35.0
2000	214	14.0	169	12.0	140	12.0	108	11.0	90	10.0	10500							660	43.0	417	37.0
2100	224	14.0	175	12.0	144	12.0	110	11.0	90	10.0	11000									449	39.0
2200	230	15.0	179	13.0	147	13.0	112	11.0	90	10.0	11500									503	41.0
2300	236	15.0	182	13.0	149	13.0	113	12.0	90	11.0	12000									543	44.0
2400	244	16.0	186	13.0	152	13.0	114	12.0	90	11.0	12500									636	46.0
2500	251	16.0	190	13.0	155	13.0	115	12.0	90	11.0	13000									680	49.0
2600	265	16.0	198	14.0	160	14.0	121	12.0	92	11.0											
2700	273	17.0	204	14.0	163	14.0	122	13.0	92	11.0											
2800	281	17.0	209	14.0	167	14.0	125	13.0	93	12.0											
2900	289	18.0	214	15.0	171	15.0	127	13.0	94	12.0											
3000	297	18.0	219	15.0	174	15.0	129	14.0	95	12.0											
3100	314	18.0	227	15.0	178	15.0	132	14.0	97	12.0											
3200	322	19.0	232	16.0	183	16.0	134	14.0	98	13.0											
3300	332	19.0	240	16.0	189	16.0	137	15.0	100	13.0											

RAPID FIRE TABLE V **PROPELLANT GREEN BAG M3A1**

WEAPON M109A1

Range to Crest	FUZE M557, M564					Range to Crest					
	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5		CHG 1	CHG 2	CHG 3	CHG 4	CHG 5
100	66	65	61	59	57	3300	669	415	274	199	157
200	52	49	43	39	36	3400	697	431	282	207	162
300	56	49	40	35	30	3500	728	447	293	213	167
400	63	54	43	36	30	3600		501	313	224	174
500	75	61	47	39	32	3700		517	322	231	179
600	87	70	53	42	35	3800		534	331	237	184
700	100	78	59	47	38	3900		552	342	244	189
800	113	87	64	51	41	4000		571	351	250	195
900	123	95	70	55	44	4500			420	292	227
1000	137	104	77	60	48	5000			504	338	260
1100	154	118	84	65	51	5500			620	389	293
1200	168	127	91	70	55	6000				451	332
1300	182	136	97	75	58	6500				525	375
1400	194	145	104	80	62	7000				625	424
1500	209	155	113	85	67	7500					481
1600	233	171	123	92	72	8000					551
1700	247	182	129	96	76	8500					643
1800	261	192	136	102	80						
1900	276	202	144	107	85						
2000	292	213	151	113	89						
2100	324	233	162	121	95						
2200	341	244	170	129	99						
2300	357	255	179	135	104						
2400	374	266	187	140	109						
2500	391	279	195	146	116						
2600	440	302	206	153	120						
2700	460	313	214	159	125						
2800	478	327	222	164	130						
2900	500	339	232	170	135						
3000	519	353	240	176	140						
3100	619	388	257	186	147						
3200	645	402	265	192	152						

RAPID FIRE TABLE V **PROPELLANT WHITE BAG M4A2**

FUZE M557, M564

WEAPON M109A1

Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7	CHG 8	Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7	CHG 8
100	58	58	57	56	55	53	3300	257	185	148	101	69	47
200	41	37	35	33	32	29	3400	264	191	153	105	72	49
300	38	33	29	26	24	21	3500	272	197	158	109	74	50
400	40	33	29	25	22	18	3600	288	205	164	113	77	52
500	44	36	30	25	21	17	3700	296	211	169	117	79	54
600	50	40	33	26	21	16	3800	306	217	174	121	82	55
700	55	43	35	28	22	16	3900	314	223	181	124	84	57
800	60	47	38	29	22	16	4000	324	231	186	128	87	59
900	65	51	40	30	23	16	4500	383	267	215	152	103	67
1000	73	56	44	33	25	18	5000	450	307	244	175	118	78
1100	80	62	47	34	27	18	5500	534	349	278	197	136	88
1200	87	67	51	37	28	19	6000	645	401	312	225	154	99
1300	94	71	54	39	29	19	6500		458	352	251	175	111
1400	100	76	58	41	31	20	7000		531	396	280	194	125
1500	106	81	64	44	33	22	7500		617	446	313	220	138
1600	117	87	69	47	35	23	8000			503	346	241	154
1700	122	91	72	48	36	23	8500			575	384	269	171
1800	129	96	76	51	38	24	9000			671	423	295	189
1900	135	101	80	54	40	26	9500				470	326	208
2000	144	106	84	57	41	27	10000				525	355	229
2100	153	112	90	61	43	31	10500				591	394	250
2200	160	120	94	64	45	33	11000				680	425	272
2300	169	125	98	67	48	34	11500					478	299
2400	175	130	103	70	50	35	12000					512	323
2500	182	135	107	73	52	37	12500					595	352
2600	194	142	114	76	53	37	13000					636	379
2700	201	147	119	81	55	39	13500						418
2800	210	152	123	84	57	40	14000						445
2900	217	158	128	88	59	41	14500						493
3000	225	163	133	91	62	43	15000						525
3100	240	172	138	94	65	44	15500						596
3200	247	180	143	98	67	46	16000						635

WEAPON M109A1

FUZE, M514

Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		Range to Crest	CHG 2		CHG 3		CHG 4		CHG 5	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI
100	268	8.0	254	8.0	214	8.0	185	8.0	162	8.0	3600	528	23.0	340	20.0	251	18.0	201	17.0
200	268	8.0	254	8.0	214	8.0	185	8.0	162	8.0	3700	543	24.0	348	21.0	257	19.0	205	17.0
300	268	8.0	254	8.0	214	8.0	185	8.0	162	8.0	3800	559	25.0	356	21.0	262	19.0	209	18.0
400	268	8.0	254	8.0	214	8.0	185	8.0	162	8.0	3900	577	25.0	367	22.0	269	19.0	214	18.0
500	268	8.0	254	8.0	214	8.0	185	8.0	162	8.0	4000	595	26.0	375	22.0	274	20.0	219	18.0
600	248	9.0	231	9.0	214	8.0	185	8.0	162	8.0	4500			441	25.0	313	22.0	248	20.0
700	238	9.0	216	9.0	197	9.0	185	8.0	162	8.0	5000			523	27.0	357	24.0	278	22.0
800	234	10.0	208	9.0	185	9.0	172	9.0	162	8.0	5500			638	30.0	407	26.0	311	24.0
900	231	10.0	203	10.0	178	9.0	163	9.0	152	8.0	6000					467	29.0	348	26.0
1000	233	11.0	200	10.0	173	10.0	156	9.0	144	9.0	6500					540	31.0	390	28.0
1100	242	11.0	206	11.0	172	10.0	153	9.0	139	9.0	7000					639	34.0	438	30.0
1200	248	12.0	207	11.0	171	10.0	150	10.0	135	9.0	7500							494	33.0
1300	257	12.0	211	12.0	172	11.0	150	10.0	133	10.0	8000							563	35.0
1400	263	13.0	214	12.0	173	11.0	149	10.0	131	10.0	8500							654	38.0
1500	273	13.0	219	12.0	177	12.0	149	11.0	131	10.0									
1600	293	14.0	231	13.0	183	12.0	152	11.0	132	11.0									
1700	304	14.0	239	13.0	186	12.0	153	11.0	133	11.0									
1800	315	15.0	246	14.0	190	13.0	156	12.0	134	11.0									
1900	327	15.0	253	14.0	195	13.0	158	12.0	136	12.0									
2000	340	16.0	261	15.0	199	13.0	161	13.0	137	12.0									
2100	370	17.0	279	15.0	208	14.0	167	13.0	141	12.0									
2200	385	17.0	288	16.0	214	14.0	173	13.0	143	12.0									
2300	399	18.0	297	16.0	221	15.0	177	14.0	146	13.0									
2400	414	18.0	306	17.0	227	15.0	180	14.0	149	13.0									
2500	429	19.0	317	17.0	233	16.0	184	14.0	154	13.0									
2600	478	20.0	340	18.0	244	16.0	191	15.0	158	14.0									
2700	496	20.0	349	18.0	250	16.0	195	15.0	161	14.0									
2800	513	21.0	362	19.0	257	17.0	199	15.0	165	14.0									
2900	534	21.0	373	19.0	266	17.0	204	16.0	169	15.0									
3000	551	22.0	385	20.0	272	18.0	208	16.0	172	15.0									
3100	650	23.0	419	20.0	288	18.0	217	16.0	178	15.0									
3200	675	24.0	432	21.0	295	18.0	222	17.0	182	16.0									
3300	698	24.0	444	22.0	303	19.0	228	17.0	186	16.0									
3400	725	25.0	459	22.0	310	19.0	235	18.0	190	16.0									
3500	756	26.0	475	23.0	321	20.0	241	18.0	195	17.0									

RAPID FIRE TABLE V
FUZE M514 **PROPELLANT WHITE BAG M4A2** **WEAPON M109A1**

Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7		CHG 8	
	ELI	TI	ELI	TI	ELI	TI	ELI	TI	ELI	TI	ELI	TI
100	211	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
200	211	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
300	211	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
400	211	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
500	211	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
600	211	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
700	193	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
800	181	9.0	168	8.0	159	8.0	138	8.0	115	8.0	94	8.0
900	173	9.0	159	9.0	148	8.0	138	8.0	115	8.0	94	8.0
1000	169	9.0	152	9.0	140	9.0	129	8.0	115	8.0	94	8.0
1100	168	10.0	150	9.0	135	9.0	122	8.0	115	8.0	94	8.0
1200	167	10.0	147	10.0	131	9.0	117	9.0	108	8.0	94	8.0
1300	169	11.0	146	10.0	129	9.0	114	9.0	104	8.0	94	8.0
1400	169	11.0	145	10.0	127	10.0	110	9.0	100	9.0	89	8.0
1500	170	11.0	145	11.0	128	10.0	108	9.0	97	9.0	86	8.0
1600	177	12.0	147	11.0	129	10.0	107	10.0	95	9.0	83	8.0
1700	179	12.0	148	11.0	129	11.0	105	10.0	93	9.0	80	9.0
1800	183	12.0	150	12.0	130	11.0	105	10.0	92	9.0	78	9.0
1900	186	13.0	152	12.0	131	11.0	105	10.0	91	10.0	77	9.0
2000	192	13.0	154	12.0	132	12.0	105	11.0	89	10.0	77	9.0
2100	199	13.0	158	13.0	136	12.0	107	11.0	89	10.0	77	9.0
2200	204	14.0	164	13.0	138	12.0	108	11.0	89	10.0	77	9.0
2300	211	14.0	167	13.0	140	13.0	109	11.0	90	10.0	76	10.0
2400	215	15.0	170	14.0	143	13.0	110	12.0	90	11.0	75	10.0
2500	220	15.0	173	14.0	145	13.0	111	12.0	90	11.0	75	10.0
2600	232	15.0	180	14.0	152	13.0	114	12.0	91	11.0	75	10.0
2700	237	16.0	183	15.0	155	14.0	117	12.0	91	11.0	75	10.0
2800	245	16.0	187	15.0	158	14.0	119	13.0	92	12.0	75	11.0
2900	251	17.0	192	15.0	162	14.0	122	13.0	93	12.0	75	11.0
3000	257	17.0	195	16.0	165	15.0	123	13.0	94	12.0	75	11.0
3100	271	17.0	203	16.0	169	15.0	125	14.0	96	12.0	75	11.0
3200	277	18.0	210	16.0	173	15.0	128	14.0	97	13.0	76	11.0

FUZE M514

RAPID FIRE TABLE V PROPELLANT WHITE BAG M4A2

WEAPON M109A1

[illegible]

RAPID FIRE TABLE VI **PROPELLANT GREEN BAG M1**

FUZE M557 M564

WEAPON M110

Range to Crest	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5	Range Crest	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5
100	65	62	61	60	56	3400	362	284	222	179	130
200	49	43	40	38	33	3500	373	293	228	185	135
300	49	41	38	34	28	3600	408	312	240	193	140
400	52	44	39	34	27	3700	420	323	247	199	145
500	58	49	42	35	27	3800	432	332	253	204	149
600	65	54	46	39	28	3900	444	341	260	210	154
700	72	60	51	47	31	4000	458	350	267	215	158
800	80	66	55	50	33	4500	573	416	313	241	183
900	88	72	61	54	36	5000	763	498	361	277	209
1000	95	79	65	58	38	5500		608	418	314	237
1100	107	86	73	64	42	6000			491	355	266
1200	114	92	78	67	44	6500			570	413	296
1300	123	99	83	72	47	7000			691	471	329
1400	132	107	89	77	51	7500				533	368
1500	139	113	94	80	53	8000				609	407
1600	152	124	98	85	57	8500				714	452
1700	161	131	107	90	61	9000					504
1800	170	140	112	95	64	9500					565
1900	179	148	118	100	68	10000					642
2000	189	154	123	104	71	10500					754
2100	205	166	131	110	75						
2200	214	173	137	115	79						
2300	224	181	143	120	84						
2400	233	188	149	124	87						
2500	243	196	155	130	90						
2600	262	210	166	137	94						
2700	274	218	172	142	98						
2800	284	226	178	147	102						
2900	294	234	184	152	106						
3000	304	244	191	158	111						
3100	329	260	203	164	117						
3200	341	268	210	169	123						
3300	352	277	216	175	127						

RAPID FIRE TABLE VI PROPELLANT WHITE BAG M2

WEAPON M110

FUZE M557, M564							
Range to Crest	CHG 5	CHG 6	CHG 7	Range to Crest	CHG 5	CHG 6	CHG 7
100	56	55	54	3400	130	89	63
200	33	31	30	3500	135	92	65
300	28	26	23	3600	140	95	67
400	27	24	21	3700	145	99	69
500	27	23	19	3800	149	102	71
600	28	23	19	3900	154	105	73
700	31	24	19	4000	158	108	75
800	33	25	20	4500	183	128	87
900	36	27	21	5000	209	148	99
1000	38	29	22	5500	237	168	115
1100	42	32	24	6000	266	190	128
1200	44	33	25	6500	296	214	144
1300	47	35	27	7000	329	239	160
1400	51	38	28	7500	368	265	182
1500	53	39	29	8000	407	294	199
1600	57	41	31	8500	452	322	221
1700	61	44	33	9000	504	353	240
1800	64	46	34	9500	565	388	266
1900	68	49	36	10000	642	423	287
2000	71	50	37	10500		463	316
2100	75	53	38	11000		508	341
2200	79	55	40	11500		559	374
2300	84	58	42	12000		625	401
2400	87	60	44	12500		716	443
2500	90	63	46	13000			472
2600	94	65	47	13500			522
2700	98	69	49	14000			557
2800	102	72	51	14500			637
2900	106	75	53	15000			675
3000	111	78	55				
3100	117	82	58				
3200	123	85	60				
3300	127	87	62				

FUZE M514

RAPID FIRE TABLE VI PROPELLANT GREEN BAG M1

WEAPON M110

Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	354	8.0	300	8.0	293	8.0	253	8.0	218	8.0	3400	406	21.0	328	19.0	266	18.0	217	17.0	175	15.0
200	354	8.0	300	8.0	293	8.0	253	8.0	218	8.0	3500	416	21.0	336	20.0	271	18.0	222	17.0	178	16.0
300	354	8.0	300	8.0	293	8.0	253	8.0	218	8.0	3600	450	22.0	354	20.0	283	19.0	230	17.0	182	16.0
400	354	8.0	300	8.0	293	8.0	253	8.0	218	8.0	3700	461	22.0	364	21.0	289	19.0	234	18.0	186	16.0
500	354	8.0	300	8.0	293	8.0	253	8.0	218	8.0	3800	472	23.0	372	21.0	295	19.0	239	18.0	189	17.0
600	312	8.0	300	8.0	293	8.0	253	8.0	218	8.0	3900	485	23.0	380	22.0	300	20.0	243	18.0	193	17.0
700	284	9.0	271	9.0	262	8.0	253	8.0	218	8.0	4000	496	24.0	388	22.0	306	20.0	248	19.0	196	17.0
800	267	9.0	252	9.0	240	9.0	231	8.0	218	8.0	4500	606	27.0	449	25.0	346	22.0	276	21.0	216	19.0
900	253	10.0	236	9.0	225	9.0	214	9.0	200	8.0	5000			528	27.0	391	24.0	307	22.0	239	21.0
1000	244	10.0	227	10.0	213	9.0	201	9.0	186	8.0	5500			635	30.0	445	27.0	341	24.0	266	22.0
1100	241	10.0	220	10.0	207	10.0	193	9.0	176	9.0	6000					511	29.0	381	26.0	293	24.0
1200	238	11.0	216	10.0	202	10.0	187	10.0	168	9.0	6500					593	32.0	423	28.0	321	26.0
1300	237	11.0	213	11.0	197	10.0	181	10.0	161	9.0	7000					712	35.0	473	31.0	354	28.0
1400	238	12.0	213	11.0	195	11.0	178	10.0	157	10.0	7500							533	33.0	388	30.0
1500	238	12.0	212	12.0	193	11.0	175	10.0	152	10.0	8000							609	36.0	426	32.0
1600	245	13.0	217	12.0	194	11.0	173	11.0	150	10.0	8500							714	38.0	469	34.0
1700	248	13.0	218	12.0	194	12.0	172	11.0	148	10.0	9000									520	36.0
1800	252	13.0	222	13.0	194	12.0	172	11.0	146	11.0	9500									581	39.0
1900	257	14.0	226	13.0	196	12.0	173	12.0	146	11.0	10000									657	41.0
2000	264	14.0	228	14.0	198	13.0	174	12.0	146	11.0	10500									768	44.0
2100	276	15.0	237	14.0	202	13.0	176	12.0	146	11.0											
2200	282	15.0	241	14.0	205	13.0	178	13.0	147	12.0											
2300	289	16.0	246	15.0	208	14.0	180	13.0	148	12.0											
2400	295	16.0	250	15.0	211	14.0	182	13.0	149	12.0											
2500	303	17.0	256	16.0	215	15.0	185	14.0	150	13.0											
2600	319	17.0	267	16.0	223	15.0	189	14.0	151	13.0											
2700	329	17.0	273	16.0	227	15.0	192	14.0	153	13.0											
2800	337	18.0	279	17.0	231	16.0	195	15.0	155	14.0											
2900	345	18.0	285	17.0	235	16.0	198	15.0	157	14.0											
3000	353	19.0	293	18.0	240	16.0	201	15.0	160	14.0											
3100	377	19.0	308	18.0	251	17.0	206	16.0	165	14.0											
3200	387	20.0	314	18.0	256	17.0	210	16.0	169	15.0											
3300	397	20.0	322	19.0	261	17.0	214	16.0	172	15.0											

RAPID FIRE TABLE VI PROPELLANT WHITE BAG M2

FUZE M514

WEAPON M110

Range to Crest	CHG 5		CHG 6		CHG 7		Range to Crest	CHG 5		CHG 6		CHG 7	
	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI
100	218	8.0	175	8.0	147	8.0	3400	175	15.0	133	14.0	107	12.0
200	218	8.0	175	8.0	147	8.0	3500	178	16.0	135	14.0	108	13.0
300	218	8.0	175	8.0	147	8.0	3600	182	16.0	137	14.0	109	13.0
400	218	8.0	175	8.0	147	8.0	3700	186	16.0	140	15.0	110	13.0
500	218	8.0	175	8.0	147	8.0	3800	189	17.0	142	15.0	111	13.0
600	218	8.0	175	8.0	147	8.0	3900	193	17.0	144	15.0	112	14.0
700	218	8.0	175	8.0	147	8.0	4000	196	17.0	146	16.0	113	14.0
800	218	8.0	175	8.0	147	8.0	4500	216	19.0	161	17.0	120	15.0
900	200	8.0	175	8.0	147	8.0	5000	239	21.0	178	18.0	129	16.0
1000	186	8.0	175	8.0	147	8.0	5500	266	22.0	195	20.0	142	18.0
1100	176	9.0	164	8.0	147	8.0	6000	293	24.0	215	22.0	153	19.0
1200	168	9.0	155	8.0	147	8.0	6500	321	26.0	237	23.0	167	20.0
1300	161	9.0	147	9.0	139	8.0	7000	354	28.0	260	25.0	181	22.0
1400	157	10.0	142	9.0	133	8.0	7500	388	30.0	285	27.0	200	23.0
1500	152	10.0	136	9.0	126	9.0	8000	426	32.0	313	29.0	216	25.0
1600	150	10.0	132	9.0	122	9.0	8500	469	34.0	339	30.0	236	27.0
1700	148	10.0	129	10.0	118	9.0	9000	520	36.0	369	32.0	254	28.0
1800	146	11.0	128	10.0	114	9.0	9500	581	39.0	402	34.0	281	30.0
1900	146	11.0	127	10.0	112	9.0	10000	657	41.0	438	36.0	302	32.0
2000	146	11.0	125	10.0	110	10.0	10500	768	44.0	475	38.0	330	34.0
2100	146	11.0	124	11.0	107	10.0	11000			521	41.0	354	35.0
2200	147	12.0	123	11.0	106	10.0	11500			571	43.0	387	37.0
2300	148	12.0	123	11.0	105	10.0	12000			636	45.0	413	39.0
2400	149	12.0	122	11.0	106	10.0	12500			723	48.0	455	41.0
2500	150	13.0	123	12.0	106	11.0	13000					483	44.0
2600	151	13.0	124	12.0	104	11.0	13500					533	46.0
2700	153	13.0	124	12.0	104	11.0	14000					567	48.0
2800	155	14.0	125	12.0	104	11.0	14500					647	50.0
2900	157	14.0	126	13.0	104	11.0	15000					685	53.0
3000	160	14.0	127	13.0	104	12.0							
3100	165	14.0	130	13.0	106	12.0							
3200	169	15.0	131	13.0	106	12.0							
3300	172	15.0	132	14.0	107	12.0							

FUZE M572

RAPID FIRE TABLE VII PROPELLANT XM124 (Green Bag) M86A2, M85A1 (White Bag)

WEAPON M107

Range to Crest	CHG 1	CHG 2	CHG 3	Range to Crest	CHG 1	CHG 2	CHG 3	Range to Crest	CHG 2	CHG 3
100	12	10	7	3300	82	42	23	16500	421	184
200	10	7	4	3400	84	43	24	17000	446	194
300	12	8	4	3500	87	44	24	17500	484	204
400	14	9	5	3600	90	46	25	18000	512	216
500	16	10	5	3700	92	47	26	18500	559	225
600	17	10	5	3800	95	48	27	19000	590	237
700	19	11	6	3900	98	50	27	19500	659	246
800	21	12	6	4000	101	51	28	20000	696	261
900	23	13	7	4500	117	58	30	20500		272
1000	25	14	8	5000	132	67	39	21000		285
1100	28	15	8	5500	152	76	43	21500		298
1200	31	16	9	6000	169	84	48	22000		314
1300	33	17	9	6500	191	92	52	22500		327
1400	35	18	10	7000	210	100	57	23000		343
1500	37	19	11	7500	234	110	61	23500		359
1600	39	20	11	8000	257	120	66	24000		376
1700	41	22	12	8500	285	132	72	24500		392
1800	44	23	13	9000	308	142	77	25000		411
1900	46	24	13	9500	340	154	81	25500		430
2000	48	25	14	10000	368	166	87	26000		448
2100	51	27	15	10500	405	181	92	26500		471
2200	54	28	15	11000	433	193	99	27000		491
2300	56	29	16	11500	484	208	105	27500		518
2400	58	31	17	12000	516	224	112	28000		542
2500	61	32	17	12500	588	241	118	28500		574
2600	63	33	18	13000	626	259	125	29000		599
2700	66	34	19	13500	771	277	134	29500		647
2800	68	35	19	14000		297	142	30000		675
2900	71	37	20	14500		321	150	30500		757
3000	73	38	21	15000		340	158	31000		791
3100	77	39	22	15500		367	166			
3200	79	40	22	16000		390	176			

FUZE M514

RAPID FIRE TABLE VII PROPELLANT XM124 (Green Bag) M86A2, M85A1, (White Bag)

WEAPON M107

Range to Crest	CHG 1		CHG 2		CHG 3		Range to Crest	CHG 1		CHG 2		CHG 3		Range to Crest	CHG 2		CHG 3	
	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI		EL	TI	EL	TI
100	177	8.0	170	8.0	165	8.0	3300	128	13.0	88	11.0	69	10.0	16500	430	47.0	193	35.0
200	177	8.0	170	8.0	165	8.0	3400	128	13.0	87	11.0	68	10.0	17000	454	49.0	202	36.0
300	177	8.0	170	8.0	165	8.0	3500	130	14.0	87	11.0	67	10.0	17500	492	51.0	212	38.0
400	177	8.0	170	8.0	165	8.0	3600	132	14.0	88	12.0	67	10.0	18000	520	54.0	224	39.0
500	177	8.0	170	8.0	165	8.0	3700	133	14.0	88	12.0	67	10.0	18500	567	56.0	233	40.0
600	177	8.0	170	8.0	165	8.0	3800	135	14.0	88	12.0	67	11.0	19000	598	58.0	245	42.0
700	177	8.0	170	8.0	165	8.0	3900	137	15.0	89	12.0	66	11.0	19500	666	61.0	253	44.0
800	177	8.0	170	8.0	165	8.0	4000	139	15.0	89	12.0	66	11.0	20000	703	64.0	268	45.0
900	177	8.0	170	8.0	165	8.0	4500	150	16.0	91	13.0	63	11.0	20500			279	47.0
1000	177	8.0	170	8.0	165	8.0	5000	162	18.0	97	14.0	69	12.0	21000			292	48.0
1100	166	8.0	170	8.0	165	8.0	5500	179	19.0	103	15.0	70	13.0	21500			305	50.0
1200	158	8.0	170	8.0	165	8.0	6000	194	21.0	109	16.0	73	14.0	22000			320	52.0
1300	150	9.0	170	8.0	165	8.0	6500	214	22.0	115	17.0	75	14.0	22500			333	54.0
1400	144	9.0	170	8.0	165	8.0	7000	231	24.0	121	18.0	78	15.0	23000			349	55.0
1500	138	9.0	120	8.0	165	8.0	7500	254	25.0	130	19.0	81	16.0	23500			365	57.0
1600	134	9.0	115	8.0	165	8.0	8000	276	27.0	139	20.0	85	17.0	24000			382	59.0
1700	130	9.0	111	8.0	165	8.0	8500	302	29.0	149	22.0	89	18.0	24500			398	61.0
1800	128	10.0	107	9.0	165	8.0	9000	324	31.0	159	23.0	93	18.0	25000			417	63.0
1900	126	10.0	104	9.0	93	8.0	9500	356	33.0	170	24.0	97	19.0	25500			435	65.0
2000	124	10.0	101	9.0	90	8.0	10000	383	34.0	181	25.0	102	20.0	26000			453	67.0
2100	123	10.0	99	9.0	87	8.0	10500	419	36.0	195	27.0	106	21.0	26500			476	69.0
2200	123	11.0	97	9.0	84	8.0	11000	446	38.0	206	28.0	112	22.0	27000			496	71.0
2300	122	11.0	95	9.0	82	9.0	11500	497	40.0	221	30.0	118	23.0	27500			523	74.0
2400	121	11.0	94	10.0	80	9.0	12000	528	43.0	236	31.0	124	24.0	28000			547	76.0
2500	122	11.0	93	10.0	78	9.0	12500	600	45.0	253	33.0	130	25.0	28500			579	78.0
2600	122	12.0	91	10.0	76	9.0	13000	637	47.0	270	34.0	136	26.0	29000			604	81.0
2700	122	12.0	90	10.0	75	9.0	13500			288	36.0	145	27.0	29500			652	83.0
2800	122	12.0	89	10.0	73	9.0	14000			307	38.0	152	28.0	30000			680	86.0
2900	123	12.0	89	10.0	72	9.0	14500			331	40.0	160	30.0	30500			761	89.0
3000	123	12.0	88	11.0	71	9.0	15000			350	41.0	168	31.0	31000			795	92.0
3100	126	13.0	88	11.0	71	10.0	15500			376	43.0	175	32.0					
3200	126	13.0	87	11.0	69	10.0	16000			399	45.0	185	33.0					

APPENDIX G

COMMON MISTAKES AND MALPRACTICES

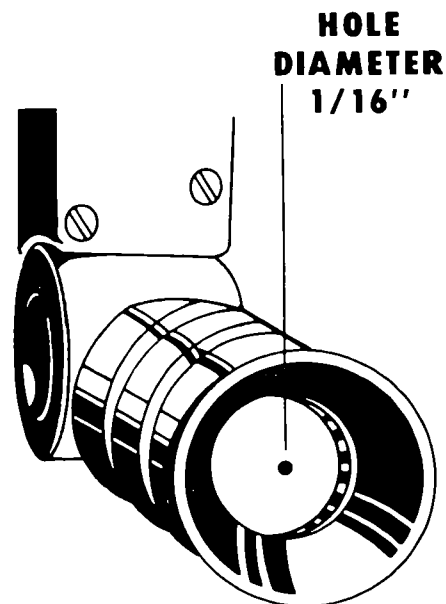
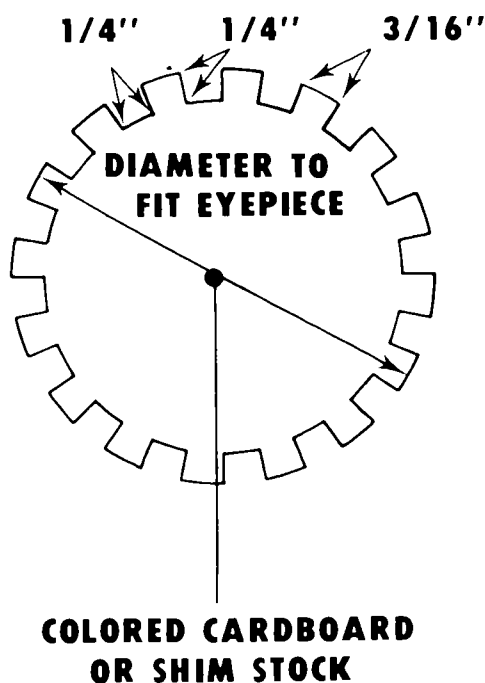
G-1. General

Inaccuracies in artillery fire cause wasted rounds and a decrease in the effectiveness of the field artillery support. A large percentage of these inaccuracies can be attributed to careless and/or improper procedures at the gun. The key to minimizing human error and careless gunnery procedures is proper training. The following problem areas will serve the commander as a starting point for evaluating the training level of his unit. The problem areas listed are only guides, and he must use them together with close, aggressive supervision and an on-going training program.

G-2. Common Mistakes

Although these mistakes may seem obvious, they occur all too often.

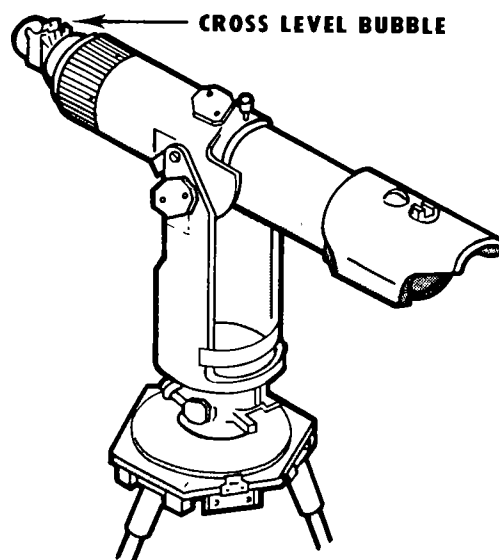
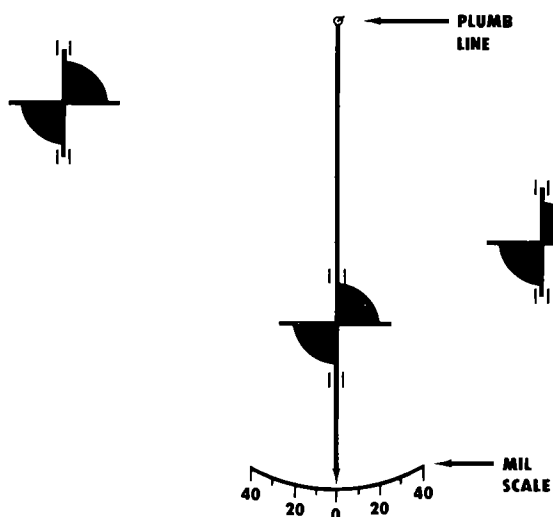
- a. Firing a wrong charge.
- b. Laying on the wrong aiming posts (especially at night).
- c. Failure to zero the gunner's aid.
- d. Transposition of numbers.
- e. Failure to level pitch and cross-level bubbles.
- f. Failure to compensate for backlash by moving the panoramic telescope from left to right when approaching an aiming point.
- g. Errors in boresighting due to parallax. The gunner must eliminate parallax by using parallax shields and breech boresights. Here's an example of a parallax shield--



G-3. Malpractices

Malpractices include blatant violations of standard doctrine as set forth in FM's, TM's, user's manuals, and other regulations. Some of the more common are--

- a. Exceeding the maximum and/or sustained rates of fire.
- b. Improper ramming, which may result in the projectile falling back on the powder when the tube is elevated (separate-loading ammunition).
- c. Improper testing of the gunner's quadrant.
- d. Incomplete and/or improper fire control alinement tests. These tests **MUST** be conducted "by the book!"
- e. Leaving projectiles and/or powder increments exposed to direct sunlight for prolonged periods of time.
- f. Failure to clean projectiles before loading.
- g. Boresighting by the testing target method in the field without compensating for the cant of the weapon trunnions. The testing target should be scribed like this--



- h. Attempting to boresight a weapon that is losing hydraulic pressure. The tube does not remain at a fixed elevation but depresses gradually, which causes errors in boresighting.
- i. Lifting a time-fuzed round with a hand around the fuze. When this is done, it is very easy to change the fuze setting.
- j. Failure to use a fuze wrench when tightening fuzes.
- k. Failure to cross-level the collimator. The cross-level bubble **MUST** be centered before the collimator can be used as an aiming point.
- l. Firing a round through an oily tube. Tubes must be **DRY** prior to firing.
- m. Exceeding the maximum practical quadrant elevation. The tabular firing tables sometimes list high angles of elevation that *should not* be fired by certain weapons. The affected

weapons are indicated below. Firing a weapon above these maximum practical QE's may result in rounds that impact base first and result in duds.

Howitzer	Charge	Maximum practical QE
M102	1	1270
	2	1280
	3	1290
	4	1305
	5	1315
	6	1310
	7	1295
M109	1	1255
	2	1270
	3	1285
	4	1295
	5	1295
	6	1285
	7	1270

Howitzer	Charge	Maximum practical QE
M109A1	1	1240
	2	1260
	3	1280
	4	1290
	5	1280
	6	1270
	7	1260
	8	1240

G-4. Use of the Aiming Circle

Generally, the person setting up the aiming circle is in a hurry--the battery is pulling in and he wants to get the guns laid as quickly as possible. This situation leads to careless procedures. Here are some of the more common ones--

- a. Failure to tighten the instrument-fixing screw securely. The head of the aiming circle will turn on the tripod, which causes an error in readings.
- b. Not clearing the area of magnetic attractions, especially weapons, steel helmets and eyeglasses, when the magnetic needle is used.
- c. Failing to first roughly orient the 0-3200 line when measuring an azimuth or an orienting angle. This leads to 3,200-mil errors.
- d. Inadvertently reading the red numbers rather than the black numbers on the azimuth scale.

e. Failure to set up the tripod so that one leg points in the approximate direction of sighting. This puts one tripod leg in the instrument operator's way as he moves around and increases the likelihood he will knock the aiming circle off level (or worse).

f. Inadvertently moving the LOWER motion when movement of the UPPER motion is desired.

g. Making a 100-mil error in reading or setting. This is easy to do if you are not careful to read the numbers on the azimuth scale in a CLOCKWISE direction.

APPENDIX H

STANDARDIZATION AGREEMENT 2047

H-1. General

a. Standardization Agreements (STANAG) are international (NATO, SEATO, CENTO) agreements designed to facilitate allied operations. Upon ratification by the United States, a STANAG is binding upon US Armed Forces (entirely or with exceptions as noted). This appendix provides information of the STANAG implemented by this manual. STANAG 2047 (EDITION NO. 2), EMERGENCY ALARMS OF HAZARD OR ATTACK.

b. It is agreed that the NATO Armed Forces, when operating on land, are to use the sounds and signals detailed herein to give emergency alarms of--

- (1) Nuclear, biological or chemical (NBC) hazards and friendly nuclear strikes.
- (2) Air attack.
- (3) Ground attack.

H-2. Definitions

For the purpose of this agreement the following definitions apply:

a. *Nuclear, biological or chemical (NBC) hazards and friendly nuclear strikes.* The presence of biological or chemical agents or radioactive matter in the vicinity of friendly troops, whether as a result of enemy or friendly action.

b. *Air attack.* The direct attack on friendly troops by aircraft or the imminent possibility thereof.

c. *Ground attack.* Any attack in platoon strength or greater into the Sector (area) of a friendly unit.

d. *Friendly nuclear strike.* The employment of nuclear weapons by friendly forces that necessitates emergency alarms to friendly troops who might be affected.

e. *Local alarm.* An alarm given in all cases when an attack or the presence of a hazard is detected. This alarm is given by any means available that produces a sound that cannot be confused with other sounds encountered in combat. Visual signals are also used.

f. *General warning.* A warning given when the hazard or attack is expected to involve a large area. The general warning is sent out by all normal means of communication to all areas that may be affected.

g. *All clear.* A signal given to indicate that the danger, for which an alarm has previously been given, no longer exists.

H-3. General Provisions

a. Sound and Visual Signals to be used for Emergency Alarms of Hazard or Attack, and the All Clear--

- (1) Are designated for use in installations, depots, headquarters or units of battalion size or smaller.
- (2) Are suitable for use in both forward and rear area.
- (3) Are given in all cases as soon as an attack or the presence of a hazard is detected. This

alarm is given by means which cannot easily be confused with other sounds encountered in combat. Visual signals are also used.

(4) Should normally be supplemented by the simultaneous use of radio and telephone.

(5) Are generally limited in range and should be repeated swiftly throughout the unit area by all who hear or see the original alarm.

b. No attempt has been made to make the types of signals described in this Agreement coincide with the types of signals that may be used in civilian defense.

c. Visual signals are included in this agreement to supplement the sound alarms under conditions when the latter may be lost as a result of other battlefield noises, or to replace them if the tactical situation does not permit the use of sound signals.

d. The signals listed at Annex A (D of A) of the STANAG are primarily intended to serve as alarms of enemy action. They may also be used, however, in emergency when friendly action could produce similar effects on friendly troops.

H-4. Specific Signals

a. Nuclear, Biological, Chemical (NBC) Hazard.

(1) *By Percussion.* Rapid and continuous beating on any metal object or any other object that produces a loud noise, such as bells, a metal triangle, an iron railing, iron pipes, empty shell cases, mess tins, steel helmets, vehicle bodies, etc.

(2) *Horns and sirens.* (When not prohibited by national authority.) A horn signal of three short blasts followed by 2 seconds of silence with the signal to be repeated for 1 minute. A siren of three long warbling sounds each separated by a silence.

(3) *Vocal alarm.* Shout "gas" or "spray" as appropriate.

(4) *Automatic alarms.* Automatic alarms for the early and rapid detection of chemical agents should, as far as possible, replace the improvised devices referred to above.

b. Air attack (notes 1 and 2 below).

(1) *Sound signals.* Continuous series of short blasts on a vehicle horn, a whistle, or a bugle or other available wind instrument. Give a long blast on the siren, with a warbling sound (when not prohibited by national authority).

(2) *Visual signals.* Rapid crossing and uncrossing of the arms fully extended above the head.

c. Ground attack (notes 1 and 2).

(1) *Sound signals.* Series of long blasts on a vehicle horn, whistle, bugle or other available wind instrument.

(2) *Visual signals.* None--unless prescribed in national or local instructions.

d. Friendly nuclear strikes (note 2).

(1) *Sound signals.* As prescribed in national or local instructions.

(2) *Visual signals.* As prescribed in national or local instructions.

e. Signals for the all clear (note 2). Release from an alarm state should normally be given orally, but when circumstances permit, the following sound signal may be used: A continuous sustained blast on a vehicle horn, a whistle, or a bugle or other wind instrument or a siren signal

with a continuous steady pitched blast 1 minute in duration.

Notes.

1. If an air or ground attack is determined to be a nuclear, biological, or chemical hazard, the appropriate NBC hazard alarm should replace or immediately follow the air or ground attack alarm as appropriate.
2. The spoken word (vocal alarm) remains the most effective means of informing troops in an emergency.



APPENDIX I

REFERENCES

Subject	Source
Abbreviations	AR 310-50
Absence Without Leave	AR 630-10
Accidents	
Motor Vehicle, Prevention	AR 385-55
Reports (for firing)	AR 75-1
Administrative Publications Index	DA Pam 310-1
Airmobile Artillery	FM 6-102, 57-35, and 100-26
Ammunition	
General	TM 9-1300-200
Artillery	TM 9-1300-203
Transportation and Storage	TM 9-1300-206
Army Aviation	FM 1-100
Awards and Decorations	AR 672-5-1
Basic Ammunition Loads	FM 101-10 series
Boobytraps	FM 5-31
Camouflage	FM 5-20
Censorship	AR 380-200
Charge Sheet	Manual for Courts-martial 1969
Classified Documents (security)	AR 380-5
Cleaning and Lubrication of Vehicles/ Equipment	Appropriate LO
Combat Tips, Lessons Learned	DA Pam 350-15 series
Communications Doctrine	FM 24-1
Complaints	AR 20-1
Correspondence Courses	DA Pam 351-20, AR 351-20
Correspondence and Messages	AR 340-15
Council Book (nonappropriated funds)	AR 230 series
Dictionary of US Army Terms	AR 310-25
Driver Selection and Training	AR 600-55, TM's 21-300 (wheeled) and TM 21-301
Driver Manuals	
Tracked Vehicles	TM 21-306
Wheeled Vehicles	TM 21-305
Duty Roster	AR 220-45
Employment of Chemical and Biological Agents	FM 3-10
Enlisted Personnel Management	AR 600-200
Equipment Maintenance	AR 750-1
Equipment Modification Work Orders (Index)	DA Pam 310-7
Examination, Drivers	AR 600-55

Subject	Source
FADAC Operation	FM 6-40-3
Field Artillery Communications	FM 6-10
Field Artillery Gunnery (Cannon)	FM 6-40, FM 6-40-5
Field Artillery Survey	FM 6-2
Field Fortifications	FM 5-15
Film Index, Army Motion Pictures	DA Pam 108-1
Fire Support Procedures	FM 6-20
Fording, Deep Water	Vehicle TM, TM 9-238
Fortification and Camouflage	FM 5-34
Graphic Training Aids Index	DA Pam 108-1
Index to	
Administrative Publications	DA Pam 310-1
Blank Forms	DA Pam 310-2
Publications (FM, TC, FT, TOE)	DA Pam 310-3
Publications (TM, TB, SM, SB, LO)	DA Pam 310-4
Leave Policy	AR 630-5
Legal Assistance	AR 608-50
Map Reading	FM 21-26
Maintenance Management	AR 710-3, TM 38-750, FM 29-2, DA Pam 750-1 and 750-18
Mess Operation	TM 10-405
Military Leadership	FM 22-100
Military Symbols	FM 21-30
Night Operations	FM 31-36
Officer Candidate School	AR 351-5
Operations of Army Forces	FM 100-5
Organization of the Army	AR 10 series
Pay	AR 37 series
Personal Affairs	DA Pam 608-2
Personnel Authorizations, Artillery	TOE 6 series
Preventive Maintenance	DA Pam 750-1, TM 38-750
Qualification, Small Arms	AR 622-10, weapon FM, FM 23 series
Rail Movement Preparation	TM for equipment
Rations	AR 30-46
Road Marches	FM 101-10-1, FM 6-20
Riverine Operations	FM 31-75
Safety Program	AR 385-10, AR 385-55, DA Pam 385-1
Safety Regulations (firing)	AR 385-63
Salvage/Surplus Property Disposal	AR 755-2
Schools	AR 351-1, AR 351-25, DA Pam 351-4
Training	AR 350-1, FM 21-6, FM 6-40-5, TC 21-5-1, TC 21-5-2
Troop Information and Education	DA Pam 360 series
Uniform Regulations	AR 670-5

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FM 6-50

1 JULY 1976

By Order of the Secretary of the Army:

FRED C. WEYAND
General, United States Army
Chief of Staff

Official:

PAUL T. SMITH
Major General, United States Army
The Adjutant General

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APPENDIX A

CHARACTERISTICS AND CAPABILITIES OF ARTILLERY WEAPONS

*Chg 8: 1 rd/min for 60 min, then 1 rd/3 min thereafter
**Maximum of 300 zone 3 rounds
HSW--Horizontal sliding wedge
VSW--Vertical sliding wedge
STIS--Stepped thread, interrupted screw
TIS--Thread interrupted screw
Elec--Electric
EI--Electrical or inertia
PH--Percussion hammer
CP--Continuous pull
SIP--Spring actuated, inertia percussion
HPC--Hydropneumatic constant
CHSP--Concentric hydrospring
HPV--Hydropneumatic variable
HP--Hydropneumatic
HS--Hydrospring
MB--Modified box
BG--Box girder

75-mm pack howitzer M116, towed	381	8,800	47	20,000	HSW	CP M13	HPC	27	32	1,250	-89	800	24	Axle	53	53	4.1	MB	Spring	None	20	M1	M3A1	M62	M1	1,440	1,440	10'6"	4'2"	2'9"	7	8	2.5	Hel MP 1 1/2-ton	6-78	9-319	14	18
105-mm howitzer M101A1, towed	472	11,000	101.3	M2A1 5,000 M2A2 7,500	HSW	CP M13	HPC	39	42	1,100	-89	1,156	10	Pintle	409	400	19	Split	Spring	Hand	40	M12A7D	M21A1	M16A10	M4A1	4,980	4,980	19'8"	7'	5'	3	10	3	Hel 2 1/2-ton	6-75	9-1015-203-12	33	42
105-mm howitzer M102, towed	494	11,500	131.6	5,000	VSW	CP	HPV	30	50	1,150	-89	1,333	10	Ball and socket	6,400	6,400	19	BG	Spring	Hand	40	M113	M134	M114	M14	3,017	3,140	22'	6'4"	5'3"	4	10	3	Hel Prcht 5/4-ton	6-70	9-1015-234-12	33	42
105-mm howitzer M52A1, SP	472	11,000	101.3	5,000	VSW	SIP	CHSP	11 3/4	13	None	-178	1,156	21	Ring and race	1,066	1,066	21	None	None	Veh	Track	M100	M99	M101	M1A1	53,000	53,000	19'	10'4"	10'11"	1	10	3	SP	6-77	9-7204	33	42
105-mm howitzer M108, SP	494	11,500	131.6	3,000	VSW	SIP	CHSP	12	12	None	-106	1,333	10	Ring and race	6,400	6,400	10	None	Spring	Veh	Track	M117	M145	M118	M15	46,221	46,221	20'1"	10'4"	10'	1	10	3	SP	6-79	9-2350-217-10	33	42
155-mm howitzer M114A1, towed 155-mm howitzer M123A1, aux prop	564	14,600	149.2	M1 2,000 M1A1 7,500	STIS	PH M1	HPV	41	60	1,650	0	1,156	14.8	Pintle	448	418	10.3	Split	Spring	Air hand	55	M12A7C	M25		M1A1	12,950 13,540	12,950 13,540	24'	8'	5'11"	5	4	1	5-ton	6-81	9-1025-200-12	95	109
155-mm howitzer M44A1, SP	564	14,600	149.2	5,000	STIS	CP M34	HS	19 1/4	19 3/8	None	-89	1,040	F16.1 S2	Ring and race	533	533	6	Veh spade	Tor-sion bar	Veh	Track	M12A7K	M95	M93	M1A1	64,000	64,000	20'	10'8"	10'2"	1	4	1	SP	6-92	9-7004	95	109
155-mm howitzer M109, SP	564	14,600	175.6 W/MB 150.9 WO/MB	M126 5,000 M126A1 7,500	TIS	CP M35	HPV	24	36	700	-53	1,333	10	Ring and race	6,400	6,400	10	Veh spade	Hy-draulic gas	Veh	Track	M117	M145	M118C	M15	52,460	52,460	21'8"	10'4"	10'1"	1	4	1	SP	6-88	9-2350-217-10N	95	109
155-mm howitzer M109A1, SP	684	18,100 w/chg 8 14,800 w/chg 7	271.6	5,000	TIS	CP M35	HPV	24	36	700	-53	1,333	10	Ring and race	6,400	6,400	10	Veh spade	Hy-draulic gas	Veh	Track	M117	M145	M118C1	M15	53,060	53,060	29'8"	10'4"	10'1"	1	4	0.1	SP	6-88	9-2350-217-10N	95	109
8-inch howitzer M110E2, SP	747	20,700	324.0	7,000	STIS	CP M35	HPV	29	70	1,900	+35	1,156	2.5	Ring and race	533	533	5	Veh spade	Pneu	Veh	Track	M115	M137		M15	62,100	62,100	33'6"	10'4"	9'7"	2	1.5	0.5	SP	6-94	9-2300-216-10	200	228
8-inch howitzer M110, SP	594	16,800	216.0	7,500	STIS	CP M35	HPV	29	70	1,900	+35	1,156	2.5	Ring and race	533	533	5	Veh spade	Pneu	Veh	Track	M115	M137	M116	M15	58,500	58,500	24'6"	10'4"	9'7"	2	1.5	0.5	SP	6-94	9-2300-216-10	200	228
175-mm gun M107, SP	914	32,700	422	**400	STIS	CP M35	HPV	29	70	2,300	+35	1,156	2.5	Ring race	533	533	5	Veh spade	Pneu	Veh	Track	M115	M137	M116C	M15	62,100	62,100	37'1"	10'4"	11'5"	3	1.5	0.5	SP	6-94	9-2300-216-10	147	202
4.2-inch mortar M30	293	5,650	68.5	4.221" Pullover	NA	Fixed firing pin	Spring only	NA	NA	NA	800	1,065		Screw	125	125		Base plate	NA	NA	NA	M34A2	M79	NA	M1A1	671	671	NA	NA	NA	1 to 3	15 to 20	APC Prcht 5/4-ton Hel	23-92	9-2008	26	26	
115-mm multiple rocket launcher M91	NA	10,600	NA	NA	NA	Elec	NA	NA	NA	NA	+14	1,067	6.37	Pintle	178	178	1.9	Split	None	None	25	XM53 E2	XM7	XM109	M1A1	4,240 (Loaded)	1,200	12'8"	7'6"	5'11"	30	45 rds in 15 sec	2 1/2-ton	6-54	9-1055-215-12	58	74	

Notes

MP--Mule pack
Prcht--Parachute
1/4-ton--Jeep
2 1/2-ton--Truck
M8--Tractor
T10--Transporter
5-ton--Truck
3/4-ton--Truck
10-ton--Truck
Hel--Helicopter

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